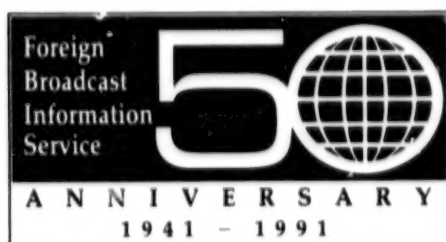


JPRS-EST-91-004  
6 MARCH 1991



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# ***JPRS Report***

# **Science & Technology**

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***Europe***

# Science & Technology Europe

JPRS-EST-91-004

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6 March 1991

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## ADVANCED MATERIALS

### Germany: SEP, MAN Develop Ceramic Composite For Hermes

91MI0104 Duesseldorf HANDELSBLATT in German  
28 Nov 90 p B11

[Article by August Muehlratz: "Heat Protection for the Hermes Space Transporter"]

[Excerpt] 27 November 1990 (Handelsblatt)—The emergence of new materials has always been a driving force for technical and industrial progress. Conversely, external influences have always demanded and stimulated the development of new materials. One class of materials that has merited special attention in this area over recent years is advanced ceramics.

In the light of a number of outstanding research results such as ceramic superconductors and extremely high-strength structural ceramics, it was forecast that new markets would open up for ceramics and that they would enjoy a general innovative thrust. In fact the ceramics market is developing steadily at something above the average rate. Faster growth is inhibited by a property typical of conventional (monolithic) ceramics: their brittleness and fragility.

The cause lies in the microstructure of ceramic materials, which prevents them from reducing critical mechanical tensions by deformation, which tough metals can do. Once a crack has occurred, it propagates abruptly and results in a complete fracture. This means that ceramics produced using traditional powder methods have intrinsic limitations as far as operational reliability and damage tolerance are concerned.

### Fiber Reinforcement Considerably Increases Fracture Resistance

Fiber-reinforced ceramics provide a real solution to this shortcoming. Silicon carbide (SiC), long silicon carbide fibers, or carbon (C) fibers are embedded in a ceramic matrix, just as steel rods are incorporated into concrete to build reinforced concrete.

The fiber reinforcement considerably increases the fracture resistance of ceramics. Whenever excess local stress opens up a crack in the matrix, the many ramifications and bends in the embedded fibers halt it, and no damage arises as these processes absorb the energy that propagates the crack. The fibers bridge the microcracks that occur, thus maintaining the component's loading capacity.

As with metals, additional supercritical stresses cause gradual material fatigue. The mechanisms responsible for the increase in strength act at microscopic level, as the fibers' diameter is about 10 micrometers. Between 500 and 12,000 fibers are combined to form threads, which are then woven into a fabric. The end results are components with properties that are essential to their

functionality: dynamic loading capacity, resistance to temperature variations, damage tolerance, and, consequently, reliability.

These special features of fiber-reinforced ceramics, combined with the basic properties of ceramics: high strength/weight ratio, rigidity, and corrosion and wear resistance, make them a generally attractive material for structural uses. However, these materials acquire particular importance in high-temperature applications, where their decisive characteristic is specific (or weight-related) strength as a function of temperature.

### Ideal for Load-Bearing Lightweight Structures

This is why fiber-reinforced ceramics have an undoubted advantage for hot, load-bearing lightweight structures. The properties of fiber-reinforced ceramics perfectly match the requirements laid down for the structural materials needed for current European manned space mission programs.

The Hermes space transporter should be cited in this context. Being smaller than the U.S. shuttle, it has considerably higher specific requirements. A new, lighter, thermal protection system (TPS) has been designed to meet reliability, serviceability, and payload specifications.

The newly developed structure comprises C/SiC shingles that form the aerodynamic outer skin, and ultralight multilayer insulation made from aluminum oxide fiber-reinforced ceramics and integrated into the shingles. This combination ensures greater reliability and serviceability, a considerable weight reduction, and substantially higher heat protection capacity than the U.S. shuttle's TPS.

The system will be jointly developed and manufactured by SEP [European Propellant Company] and MAN [Augsburg-Nuernberg Machinery Factory] Technology. In order to reduce their weight, aeronautical components such as the wing edges and wing tips, control surface, and flaps will be developed as hot bearing structures, which means that they will be neither insulated nor cooled. C/SiC will be used here, too.

The ceramic components will be manufactured using the chemical vapor infiltration (CVI) method, which is new to ceramics and exploits the high penetration capacity of gases to insert the matrix into the microscopic interstices in the SiC or C fabrics. The gas mixture contains a component, methyltrichlorosilane ( $\text{CH}_3\text{SiCl}_3$ ), that precipitates the SiC matrix at process temperature as a result of thermal decomposition in the fiber structure. The fiber structure is arranged according to the load to be borne by the component, and during the process it is kept in the component mold. This method is referred to as "constructed material" and "quasi-final form manufacture."

The multilayer insulation incorporated into the tiles is a new development achieved under the Hermes project.

The sol-gel process, a colloid-chemical method, is used to produce very thin aluminum oxide ( $\text{Al}_2\text{O}_3$ ) foils as substrates for highly reflective noble metal layers. These ceramic foils, which weigh as little as  $30 \text{ g/m}^2$ , can only be produced as fiber composites. The bearing fibers are made of aluminum oxide and have a diameter of approximately 3 micrometers. The stacks of coated foils reflect heat rays, thus insulating the cold structure of the Hermes space transporter underneath them from a  $1,400^\circ\text{C}$  reentry temperature surge.

#### Subjected to Heavy Stresses During Extensive Tests

SEP has already manufactured prototype components for the Hermes thermal protection system and hot structure and tested them extensively under operationally relevant stresses. For example, the C/SiC wing edge has been subjected to 16 air load cycles at  $1550^\circ\text{C}$  and two cycles at  $1700^\circ\text{C}$ . These tests have confirmed the advantages of fiber-reinforced ceramics and the viability of both the TPS and the components.

Another development project of particular importance for fiber-reinforced ceramics is the hypersonic technology project, which represents the preliminary stage of the Saenger program. This involves a two-stage aircraft capable of reaching near-earth orbits and designed for horizontal take-off and landing to ensure full recoverability. The aim is a marked reduction in payload costs as compared with only partially recoverable space transport systems. A key role is played by the newly developed hydrogen-fueled engine technology.

Once again, fiber-reinforced ceramics prove their worth in the light of the high operational requirements, especially as far as propulsion is concerned. Requirements are basically similar to those of the space transporter, with the additional need for more cost-effective production of fiber-reinforced ceramic components. Greater component integration and improvements to the manufacturing process are steps in this direction. This work is being undertaken within a technology program funded by the BMFT [Federal Ministry of Research and Technology] involving the use of a demonstration component.

In the long term, the industrial companies involved are interested in exploiting the technology developed on a wider front, as indeed their considerable investment in the project would indicate. A logical progression would be to apply the results in the aircraft industry. The new propulsion system would be attractive because, using hydrogen, which is a clean fuel, it would be environmentally innocuous, and because its lower weight and higher specific performance would make for lower consumption. France has already begun introducing fiber-reinforced ceramics in aircraft engines and successfully tested some SiC/SiC and C/SiC afterburner and jet exhaust flap components.

#### German Institute Acquires Atomic Range Measuring Capacity

91MI0097 Bonn *TECHNOLOGIE-NACHRICHTEN*  
*MANAGEMENT-INFORMATIONEN in German*  
14 Nov 90 p 10

[Text] A highly advanced small spot ESCA [electron spectroscopy for chemical analysis] system will shortly begin functioning at the Fraunhofer Institute of Silicate Research (ISC) in Wuerzburg. With this equipment, worth 1.2 million German marks [DM], it is possible to analyze material surfaces that are just a few atom diameters thick. Structures with a minimum diameter of approximately 0.2 mm [sic] can be analyzed, a considerable improvement over conventional processes. Such sophisticated equipment is currently needed for developing new high-performance materials, as the surface of a tool has an extraordinary bearing on its properties. The applications of the new ESCA equipment will include catalyst research and analyzing corrosion procedures for glass.

The institute's other advanced analytical equipment is also available to interested industrial firms for project research purposes. Besides the characteristics of surfaces and coatings, its main focus is on the characteristics of powders and sintering processes, where most experience has been acquired with ceramics, glass, inorganic-organic polymers, and bonding agents.

Further information is available from the Fraunhofer Institute of Silicate Research, Director: Dr. Hans Roggendorf, Neunerplatz 2, 8700 Wuerzburg, tel. 0931-41909-0, telefax 0931-41909-80.

#### UK: Polymerization Using Ultrasonic Waves Successful

91AN0074 Rijswijk *POLYTECHNISCH WEEKBLAD*  
*in Dutch* 25 Oct 90 p 3

[Article: "British Scientists Use Ultrasonic Sound Source for Polymerization"]

[Text] British Researchers claim that they have succeeded in producing polymers using ultrasonic sound waves. Earlier attempts had so far run up against practical hindrances.

Researchers of the University of Bath (Great Britain) used a 22-kilohertz ultrasonic sound source to polymerize different monomers. The technique is based on the phenomenon of sound waves producing high- and low-pressure areas in a solution. Apparently, these "low-pressure areas" trigger forces that are strong enough to disintegrate chemical bonds. In organic solutions, this results in the formation of radicals (extremely reactive fragments of molecules) that are able to initiate polymerization reactions.

The British scientists have succeeded in producing polymers from styrene, methylmethacrylate, butylmethacrylate, and variant forms with two of these monomers.

Polymers produced in this way have other characteristics than conventional synthetic materials. They are smaller and have less differentiated chain lengths per batch. The latter property is important because it can lead to significant quality improvements.

The successful implementation of this process requires careful control of the polymerization conditions to prevent the newly formed polymer chains from disintegrating.

## AEROSPACE, CIVIL AVIATION

### Status of European Fighter Aircraft Program Evaluated

91MI0117 Rome AIR PRESS in Italian  
28 Nov 90 pp 2859-2860

[Text] Ninety-five percent of the equipment for the first EFA [European Fighter Aircraft] prototypes has already been chosen, and more than 80 percent has already been ordered, while the European fighter's cockpit and related systems are being developed by British Aerospace's Cockpit Group at Warton. In this specific case, a simulation system (Active Cockpit Rig), specially designed for use by the test pilots of the Eurofighter companies and the air forces of the four nations involved in the program, is being utilized to evaluate the piloting characteristics of the new aircraft, the instruments adopted, and the general architecture of the cockpit.

Below is a summary of the current status of the EFA, of which various components are already under construction for the first flight prototype (PO1). The participation quotas in the EFA program are as follows: Germany 33 percent, UK 33 percent, Italy 21 percent, Spain 13 percent, and the number of series aircraft to be produced for the air forces of the four nations is now set at 765. The holdings of the companies making up Eurofighter Jagdflugzeug GmbH, incorporated in Munich in June 1986 subsequent to the signing of agreements in 1985 by the Ministers of Defense of the UK, Germany, Italy, and Spain, to manage the EFA program, including development, production, and product support, reflect those of the respective nations: British Aerospace 33 percent, MBB [Messerschmidt-Boelkow-Blohm] in association with Dornier 33 percent, Aeritalia 21 percent, and CASA [Aeronautic Constructions Company] 13 percent.

The two main development contracts for the EFA's weapons and the propulsion systems were signed on 23 November 1988 by NEFMA (NASTO European Fighter Aircraft Management Agency, the intergovernmental agency that handles the program at the governmental level), Eurofighter and Eurojet Turbo GmbH, the latter being the four-nation company responsible for all aspects of engine development, as Eurofighter is for the airframe. The holdings of the companies comprising Eurojet, which also has its headquarters in Munich, again reflect the distribution of the governmental participations: Rolls Royce—33 percent, MTU [Motor and

Turbine Union]—33 percent, FiatAvio—21 percent, ITP—13 percent. The last is an aircraft engine company headquartered in Bilbao, set up and owned entirely by the Spanish Government, and incorporated in April 1989 with a strong British representation in the capital (45 percent Rolls Royce), the remaining 55 percent of which is held by a consortium composed of Sener, CASA, and Bazan (about 51 percent) and the Bank of Bilbao (about 5 percent).

The design of the EFA must reflect the ESR-D (European Staff Requirement for Development) specification signed by the commanders-in-chief of the British, German, Italian, and Spanish air forces in September 1987 for an aircraft designed specifically for air-to-air combat and capable of air-to-ground missions as required.

Eight flight prototypes of the EFA are scheduled. The first (PO1), which is under assembly in Germany, will mount the provisional RB199-122 engines derived from those of the Tornado, and will "roll out" at Manching at the end of 1991. Three months later the PO2, the first prototype assembled in the UK, should fly at Warton. The PO3 prototype, also assembled in the UK and scheduled to fly six months after the PO2, again at Warton, will be the first two-seater and the first to be equipped with the EFA's own Eurojet EJ200 engines. The Italian prototypes, the PO4 and PO8, are scheduled to fly at Turin-Caselle, while the Spanish company CASA will assemble the PO5 (the first with a radar) and the PO6. The eight prototypes will be assembled with parts constructed by all of the four member nations and will all fly within two years of the PO1's first flight.

The main tasks assigned to each of the eight flight prototypes have also been finalized. The PO1 and PO2 will carry out an analysis of the flight envelope and engine development tests (their subsequent refitting with an EJ200 in place of the original RB199-122 is foreseeable). The PO3 will carry out engine tests which will also serve to develop the two-seater version. In Italy the PO4 will test the separation of onboard firing and war weapons. The PO5, the first with a complete avionics system, will carry out the first evaluation of the radar and avionics systems while the PO6 will be used for avionics integration. The Spanish PO7 will carry out additional tests on the onboard systems and the avionics, while the PO8 will carry out avionics and performance tests in Italy. According to plans, as yet unchanged, the first EFA should fly in 1996.

The FSD (Full-Scale Development) phase of the Eurojet EJ200 engine is well underway with FSD models already assembled or being assembled at Bristol (Rolls-Royce), Munich (MTU), and Turin (FiatAvio). A total of twelve EJ200s are planned for the FSD phase to confirm project characteristics in order to mount the engines designed for flight tests on the aircraft prototypes. Project tests conducted in Bristol, Munich, and Turin have already confirmed many of the performances anticipated in the design phase ahead of the estimated time, particularly



for flights at sea level and higher altitudes. Flight simulations of up to Mach 1.8 at an altitude of 30,000 feet (more than 9,100 meters) have also been carried out.

#### EFA: The First Specifications

Wingspan	10.50 meters
Overall length	14.50 meters
Empty weight (basic)	9,750 kg
Maximum weight external loads	6,500 kg
Maximum takeoff weight	21,009 kg
Maximum speed in level flight	more than Mach 1.8
Minimum operative runway length	500 meters
G limits	+9g/-3g with internal fuel and two AMRAAM missiles)
Engines	two RB199-122 71.2 kN (7,264 kg/sp) maximum thrust on PO1 and PO2. Two EJ200 of 90 kN (9,008 kg/sp) maximum thrust.

#### European Consortium Formed To Build Hermes Space Plane

91WS0063B Paris LE MONDE in French 8 Nov 90 p 9

[Article by special Brussels correspondent Jean-Paul Dufour: "European Manufacturers Create Hermespace Company"; first two paragraphs are LE MONDE introduction]

[Text] The creation of Hermespace, an industrial firm to develop the European space plane Hermes, was announced Tuesday 6 November in Brussels. Hermespace is a joint-stock company, with a board of trustees and a directorate, whose shareholders will consist of the four main European firms working on Hermes.

Deutsche Aerospace (Germany) holds 33.4 percent of shares, and Aeritalia (Italy) 15 percent. France's stake, a majority one with 51.6 percent of shares, is held by a new company, Hermespace-France, which is a joint undertaking of the Aerospatiale (51 percent) and Dassault-Aviation (49 percent) companies.

Manufacturers are ready to kick off development (fabrication of the first flying prototypes) of the European space plane Hermes, and the ball is now in the politicians' court. That was the gist of the message sent Tuesday 6 November in Brussels by the officials of Aerospatiale, Dassault-Aviation, Deutsche Aerospace, and Aeritalia companies. The creation of Hermespace Company, announced in the Belgian capital at the International Technospace Show, marks the end of a technological adventure which began in January of 1985, when the ministerial council of the European Space Agency (ESA) member states meeting in Rome decided that the Old World should strive for autonomy in manned space flight. This desire was given concrete form by the same ministers in November of 1987 in La Haye (16 October, 1987 LE MONDE) when they gave the

go-ahead for the Hermes program (as well as the super-heavy Ariane 5 launcher and the Columbus modules). Three years later, "phase 1" is complete: the craft has been described down to the last detail on paper (6 July, 1990 LE MONDE), its feasibility has been demonstrated, and its technologies have been defined and mastered.

"All that's left for manufacturers to do is submit precise proposals on technical components, industrial organization of the programs, and costs to the ESA, between now and the end of the year," explains Mr. Henri Martre, Aerospatiale CEO. This task has now fallen to Hermespace, which will also be responsible for manufacture of the space plane's two flight models. Aerospatiale, which until now has always been chief industrial contractor for the project, is thus relinquishing its place to the new European consortium. It is a self-effacement which is wholly diplomatic: The general manager position in Hermespace's directorate is, in fact, reserved for an Aerospatiale representative (in this case, Mr. Philippe Coullard, current director of the company's space programs). But he will be flanked by four other assistant general managers, representing each company, and the board of trustees will be presided on a rotating basis by a representative of Deutsche Aerospace, Aeritalia, and Hermespace-France, for three-year periods. The first president is Mr. Johann Schaffler, assistant president of Deutsche Aerospace.

These adjustments were necessary to soothe the growing irritation of certain ESA member states, Germany in particular, who were dissatisfied with what they considered France's oversized share in most European space programs. Thus France's stake was brought down from over 50 percent in the Ariane 4 program to 43 percent for Ariane 5, with the other European countries splitting the difference.

#### An Uncertain Future

The ESA, which had delegated its role as chief contractor to the National Center for Space Studies (CNES, French) for Hermes, recently opted to form a joint ESA-CNES team to handle the project. One expects that, in exchange, Germany will adopt the same spirit of conciliation for the unmanned Columbus module project, which it leads. Mr. Schaffler moreover indicated that the creation of a company similar to Hermespace should soon be announced for Columbus.

Not all problems have been smoothed over, however. First of all, Hermespace members must try not to exceed by more than 20 percent (at which point states can drop out of the project) the 4.5 million-ecu budget (about 31 billion French francs) set in 1987 in La Haye. "It will be difficult," admits an Aerospatiale official. And even if they manage this, the go-ahead that ESA ministers should normally give in June, 1991 for the project's second phase is far from assured.

Indeed, much has changed since the program began. For one, reunification with the GDR is costing Germany, a

big moneylender for Hermes and especially Columbia, dearly. For another, budget restrictions have prompted NASA to cut the size and delay the implementation of its orbital station Freedom. Servicing of its habitable module, the APM Columbus, was one of the main reasons for building the European space plane.

"European autonomy in manned flights is still an important goal for us," acknowledges a high-ranking French space bureaucrat, "but the way we get there may change." Besides simply pursuing the Hermes and Columbus programs, several other options are being considered. The APM module, linked to the Freedom station, could be delayed indefinitely in favor of a single module, the MTF, a sort of big laboratory-satellite able to be visited regularly by Hermes astronauts. In the face of NASA's hesitations, there is also talk of the possibility of launching a purely European orbital station project. That would obviously prompt European ministers to recommend "an additional study phase" of one or two years, a breather that would suit everyone.

Whatever the final decision on Hermes and Columbus, however, the fate of the Ariane 5 heavy launcher does not seem threatened. For the Ariane 5, the launch of the European space plane will be just one more job, alongside the orbital launches of communications satellites, whose economic value needs no further proof.

### **Laser Technology Streamlines Aerospatiale Production Line**

91WS0056A Paris L'USINE NOUVELLE/  
TECHNOLOGIES in French 18 Oct 90 pp 15-16

[Article by Michel Vilnat: "Aeronautics: Laser Oriented; "Technological Turning Point With the Introduction of Laser-Cutting and Laser-Welding at the Aerospatiale Saint-Eloi Plant]

[Text] The arrival of two Lumonics Laserdyne 780 laser machines at the Aerospatiale Saint-Eloi plant could signal a complete change in the manufacturing practices of the aeronautical industry.

For light alloys, of course, laser welding will not replace riveting, but for stainless steel and Inconel, including structural parts, it might. The introduction of laser technology at the Saint-Eloi sheetmetal workshop has drastically changed production methods. It has reduced from 125 to 50 days the production cycle of the forward cantilevers of the future Airbus A340 engine pylons. This was achieved with a CO<sub>2</sub> source mounted on a six-axis robot that can cut, drill and weld automatically at the same station. It now takes only 3 minutes instead of 1 hour to cut the stainless steel sheet used for the casing cover.

Better still, thanks to the development of new tooling (now undergoing certification) to position subassemblies on the framework, it will be possible to weld casing parts at speeds of 600-800 mm/min fully automatically (at

present these elements are riveted). These gains are due primarily to an improvement in quality. Actually, with laser technology there is no deformation of the metal. This in turn eliminates the need for manual straightening of sheetmetal parts. Formerly, after clip flashing the sheetmetal, the operator had to straighten it by hand, with a hammer. And again after welding. In addition, pre-welding pickling, which was indispensable with the old method, is no longer necessary. This has led to a complete reorganization of the Saint-Eloi sheetmetal workshop. Obviously, casing covers are not the only parts concerned. The Laserdyne 780 machines are also used to make intricate piping. In a first stage, the parts are cut and then edge-welded. Thus, the fabrication cycle no longer requires frequent back and forth operations, as was the case in the past. The new investment has also improved working conditions by nearly eliminating straightening operations, which made a lot of noise. Reliability is another strong point of the Lumonics system which operates in three 8-hour shifts. "In six months, the mirrors were adjusted only twice. And the second time it was because of a specific requirement: We needed extremely accurate focusing of the beam for a special test," one of the technicians who operate the system told us.

Ease of programming is another asset of the Lumonics machine that eased the transition to production. In fact, the company has developed a very simple language to be used by operators. In spite of this, a part of average complexity will require about 10 hours from receipt of the drawing to completion of the first prototype through on-line programming.

Off-line programming is also possible, in particular for complex parts. The program developed by the engineering department is downloaded directly to the CAD system. In this case, experts estimate that time savings amount to 300 percent, compared with on-line programming. All these advantages have made starting up easier and faster. Hardly two months elapsed between delivery of the first Laserdyne 780 and its setting into three 8-hour shift operation. The second machine took only one week! This system, plus the flexible assembly workshop to be set into service soon, will make it possible to cut the production time of a complete engine pylon assembly from 16 to seven months, and to reduce in-process inventories by 50 percent. "This productivity improvement was a must to enable us to fill orders which are expected to reach 60 pylons per month soon," a member of the management team explained.

### **[Box, p 16]**

Designed by Lumonics, the Laserdyne 780 machine is equipped with a 1,750-watt CO<sub>2</sub> source which can cut stainless steel sheets 1.5 mm thick at up to 2 m/s. It possesses three remarkable characteristics:

- Only five mirrors are required to guide the laser beam to the part. As a result, frequent adjustments are no longer necessary;

- In order to make up for any shape defects in the sheet to be welded, the laser head is provided with a capacitive sensor which automatically adjusts the focus. However, contrary to other devices, this one works on all five axes simultaneously. The laser head always retains the ideal orientation, yielding greater precision;
- To avoid the detrimental consequences of a collision between a part and the laser head, the head is provided with a microswitch that immediately cuts off the power supply to the robot axis motors. The arm then becomes "limp" and the beam is cut off. However, to make reinitialization easier, the positions of the axes are memorized.

### MAXUS Microgravity Program Presented

91AN0089 *Utrecht ELGRA NEWS in English* No 12, 1990 pp 83-84

[Article by L. Bjorn and B. Franke: "MAXUS—A New German/Swedish Sounding Rocket Programme for Long-Duration Microgravity Flights"]

[Text] The improved capability of modern sounding rocket technique is fully explored in the new MAXUS programme. This programme, conducted jointly by MBB/ERNO, Germany and the Swedish Space Corporation uses a newly developed guided sounding rocket to launch microgravity payloads of 680 kg to 830 km altitude giving 14 minutes of exoatmospheric microgravity conditions. The payload weight includes 420 kg of experiment weight.

The first launch will take place in the spring of 1991 and will be followed by at least one yearly launch. The launch site is Esrange in Northern Sweden where the well-proven land recovery system provides fast and reliable retrieval of samples.

Sounding rockets have to date provided a large fraction of all the flight opportunities which have been used for microgravity sciences. The major restriction with the existing sounding rockets is that the time in microgravity is limited to 7 minutes or less. Many experiments require a longer time to obtain meaningful results. Therefore, a study was performed during 1987-88 to find a launch vehicle and define a suitable system for longer-duration flights. The conclusion of this study was that the best rocket alternative is Castor IV B.

The Castor IV is qualified as strap-on booster on Delta II. In a development programme it has been equipped with a flexible nozzle by Thiokol Corporation, which has also modified the grain shape to give a suitable thrust profile for sounding rocket applications. The new version, the Castor IV B rocket, has a launching capacity of 680 kg of gross payload weight to about 830 km, which is required for a microgravity time of 14 minutes.

The launching of rockets to 830 km from Esrange poses nontrivial problems of rocket guidance. The horizontal

extent of the rocket trajectory is limited to less than 70 km with a 1-sigma dispersion value of 15 km. Therefore, Sweden has undertaken to develop the advanced guidance system which will be used for guidance of the nonspinning Castor IV B vehicle.

A major upgrading of the Esrange sounding rocket facilities has been made. A new and larger Payload and Experiment Control Center with a number of preparation laboratories for Biosciences has been built adjacent to the existing block house and a new launcher for heavy rockets is being installed.

MAXUS will be offered at a reasonable price as compared to the price for TEXUS and MASER. Therefore, MAXUS is believed to become a much requested opportunity for microgravity flights.

The paper presents pertinent technical details of MAXUS and covers the programmatic aspects of this new flight opportunity which is offered to the European and international microgravity communities.

### Germany: Future Joint Aerospace Projects Presented

91MI0107 *Bonn BMFT JOURNAL in German*, Nov 90 p 11

[Text] Since early October, six German astronauts have been training for two space missions to be carried out in 1992. Federal research minister Heinz Riesenhuber presented the astronauts to the public during the 41st International Astronauts Conference in Dresden. Two of the astronauts have been allocated to the MIR '92 mission planned for the spring of 1992: Klaus Dietrich Flade and D. Reinhold Ewald. The other four have been allocated to the German D-2 spacelab mission, which is due to start in the fall of 1992 with the American shuttle: Dr. Renate Bruemmer, Hans-Wilhelm Schlegel, Dr. Gerhard Thiele, and Dr. Ulrich Walter. Only two of the four candidates training for D-2 and one of the astronauts preparing for MIR '92 will actually go into space. MIR '92 is the first joint FRG-Soviet Union project. During the eight-day mission, planned for March 1992, the German astronaut is scheduled to perform a total of 15 scientific experiments, mostly related to medical projects.

This project provides a good opportunity to gain experience in operational space medicine, radiation protection in space, and space station operation with a view toward securing an adequate place for the FRG in future European manned space missions.

The D-2 spacelab mission plays a key role both as a continuation of the scientific experiment programs started in 1985 with D-1, and as a preparatory step toward the operation of the European space station, Columbus.

D-2 is an FRG-led mission involving 11 European partners under the aegis of the European Space Agency (ESA), the American National Aeronautics and Space

Administration (NASA), and Japanese industry. The mission will involve basic and applied research on materials science, process technology, and food science. Ninety-two experiments and/or batches of experiments will be carried out using 28 sets of apparatus and with the participation of 27 universities and other bodies from Germany. Compared with the D-1 mission, the scientific research programs now place greater emphasis on applications-oriented work on crystal growth and human physiology. The mission will provide the first opportunity to test new automation, robotics, and remote control processes for laying out, operating, and controlling payloads and laboratory units in space. Both projects are being carried out by the German Aerospace Research Institute (DLR) with financial support from the BMFT [Federal Ministry of Research and Technology] and the German Space Agency (DARA).

#### Microgravity for 4.74 Seconds

The Bremen gravity tower at Bremen University was recently opened to research and industry. This laboratory, designed to create short-term microgravity conditions, fills a gap in the range of microgravity experiments facilities. The first of its kind in Europe, it can be used to perform tests that do not require the lengthy period of time in microgravity conditions that only ballistic missiles and the spacelab can provide. In the 146-meter high Bremen gravity tower, microgravity conditions of less than a millionth of the acceleration due to gravity can be created many times a day for 4.74 seconds in free fall from 110 meters. A gravity capsule that is dropped down an evacuated steel pipe and then slowed down in a tank full of plastic granules is used for the experiments. The short test time provided by the free fall is enough to study a whole series of important gravity-dependent phenomena. About 1,200 applications for gravity tests have been submitted by scientists working in fluid physics, materials science, and physical chemistry, who wish to exploit these outstanding test conditions for single or multiple experiments. The BMFT has contributed 7.2 million German marks [DM] toward the gravity tower equipment, which has a total cost of DM19.5 million.

#### German Institute Receives Alloy Samples From MIR Space Station

91MI0155 Bonn WISSENSCHAFT WIRTSCHAFT POLITIK in German 19 Dec 90 p 3

[Text] The Space Simulation Institute at the German Aerospace Research Institute (DLR) has received a package from space, delivered by Czech professors Cestmir Barta and Alex Triska. At the beginning of the week, the scientists from the Physics Institute at the CSFR Academy of Sciences brought some specimens of molten material from a materials science experiment to Cologne-Porz. The special metal alloy, prepared in Cologne, had been subjected to the effects of microgravity for four weeks on board the Soviet space station

MIR. The scientists involved in this joint German-Czech-Soviet experiment had set out to supercool a metal alloy without bringing it into contact with the surrounding wall. This feat was achieved by embedding the specimen in a glass melt, where no sedimentation occurs at microgravity. The experimenters expect analysis to show that the molten material cools to about 200°C below its melting point in the course of the experiment. They hope that it will be possible to create metals with completely new properties by this method. Instruments including a scanning electron microscope are being used to assess the experiment. A follow-up experiment of the same kind will be part of the luggage of one of the two German scientist astronauts in 1992. The Space Simulation Institute in Cologne is also preparing a comparable experiment on molten material as part of the D-2 Spacelab mission.

#### Italy: Rome Space Conference Summarized

91MI0092 Rome SPAZIO INFORMAZIONI in Italian 7-14 Nov 90 pp 2-4

[Text] Rome 14 Nov (Spazio Informazioni)—“I have proposed that we create a Space Fund that would provide industry with access to facilitated lines of credit in capital and interest accounts in addition to the normal resources available through the Italian Space Agency and the Italian Aerospace Research Center.” This was stated by the under secretary for universities and research, Senator Learco Saporito, during the recent Conference on Space (on the theme: “The Industrialization of Space: Returns on Investments”) held in Rome as part of the 37th International Assembly on Electronics, Space, and Energy. The under secretary noted that “this fund is the instrument that will serve to spare the ASI [Italian Space Agency] and industry the apprehension that always precedes parliamentary decisions on financing for space programs within the general spending bills. It will be a kind of booster engine with the task of maintaining the upward trend. This will allow the ASI to plan realistically and will allow business to calculate how much financing to dedicate to the various programs.” Senator Saporito also emphasized that in order to create this fund, it will be necessary to establish a bill for this purpose in collaboration with the Budget and Treasury Ministries. Lastly, the under secretary revealed that he requested the new director general of the European Space Agency (ESA), Dr. Jean-Marie Luton, that an Italian representative be included as an observer in the ESA delegation that will negotiate with the United States on the international space station, Freedom. The same request was also put forward by Germany.

#### The Various Speeches

Many speeches were made during both the conference and the roundtable on “Cost-Benefit Analysis of Investments in Space and Program Directions.” Among these, the president of the Italian Space Agency, Professor Luciano Guerriero, stated that “we are moving toward a phase in which there is a danger of seeing all the efforts



made to date vanish. We still have much to do, and we should link ASI's research and development activities to those of other ministries such as the Postal Service, Environment, or Defense). This would not be measured on the basis of individual transactions, but within the context of a coordinated national plan. The goal of 1,300 billion lire per year for the end of the next five-year period," Professor Guerriero emphasized, referring to the contents of the new five-year National Space Plan, "represents the minimum necessary to maintain an adequate and balanced level of research and development."

Professor Massimo Trella, inspector general of the ESA, reviewing the recent developments concerning European integration and the end of the cold war, affirmed that "the ESA is considering how to deal with this international situation with regard to the management of its space plan. We cannot pretend that nothing has happened, and so we will have to start the European Space Plan from scratch and then see how to organize it for the future. The objectives of the 1990," the ESA director stated "are no longer the same as those of the past." Professor Trella also emphasized the importance of the next ministerial level ESA Conference, which should take place between July and October 1991. On the other hand, some news from the industrial sector was announced by the honorary president of Selenia Spazio, Engineer Cesare Fanto, who stated that the IRI [Institute for Industrial Reconstruction] - Finmeccanica Group company (which will soon join a new space company in the context of Alenia) is studying an export version of Italsat, the Italian telecommunications satellite. "We will have a reduced-cost (approximately 200 billion lire) satellite for export to the industrializing nations," noted Engineer Fanto, "which still do not have telecommunications networks." According to the Selenia Spazio director, considering the actual Italsat-1 satellite, "version A" (which will be launched from Kourou on 15 January 1991), and Italsat-2, "version B" (whose launch is planned for 1993, probably with an EMS [European Mobile System] apparatus on board for communicating with the mobile units supplied by EUTELSAT), a "C version" could be produced equipped with transponders with multibeam antennae for traditional telecommunications services, an EMS payload for mobile services, and a television channel. "The Foreign Affairs ministry," Engineer Fanto proposed, "should include telecommunications among its offerings to developing countries, for which it spends about 3,000 billion lire per year. In the future," he concluded, "in the context of cooperative activities for development, it would be possible to offer interested nations a complete satellite telecommunications system."

For his part, the general manager of Selenia Spazio, Dr. Andrea Pucci, emphasized in his presentation that "for several years, substantial public investment will still be necessary in the areas such as telecommunications and remote sensing and in the relative growth in the capacity of specialized Italian industry." Passing next to an

examination of industry's liabilities in its participation in the various space programs, he affirmed that: "the risk of the undertaking is wholly on us because the contracts are absolutely fixed and there are no reimbursements on cost. If, by chance, there is an error in the estimate of the technical costs or production schedules," concluded Dr. Pucci, "the entire burden falls on industry."

The secretary general of the Italian Center for Space Law, Professor Claudio Zanghi, addressed a different theme in his speech to the conference. "Italy," he said, "has not yet established any norm that is applicable *per se* and that specifically deals with space activity. We must at least be able to conform with the measures already defined in Europe." In addition, Professor Zanghi emphasized that "in the EEC system there is an inconsistency between the untouchable free market principle on one hand, and the system of national preferences and the "just return" adopted in the ESA context on the other. It is necessary," he concluded, "to resolve the problem at its origin." The speech of Dr. Franco Bevilacqua, director of advanced studies at Aeritalia's Space System Group focused on the need to carry out microgravity experiments using recoverable capsules launched in low orbit by special rockets. He noted the importance of "identifying very precise objectives, hauling programs of short duration (about one year), using reliable launch systems, and containing costs." The Aeritalia director noted, in fact, that the services offered by the Soviet Union and China allow experiments to be carried out at a cost of about \$15,000-\$20,000 per kilogram. "Only in this way," he said, "will industry be willing to invest. Otherwise, no private Italian firm will be able to enter this sector." In fact, under contract from the ASI, Aeritalia/GSS is actually studying the realization of the CARINA (Unmanned Reentry Capsule) capsule, which could be launched by a San Marco Scout rocket for microgravity experiments. During the roundtable, other comments were made by the general manager of Telespazio, Dr. Raffaele Minicucci, by Dr. Marialberto Mensa of FIAR [Italian Radio Equipment Company], by Engineer Angelo Bonanni of Carlo Gavazzi Space, and by the Science Attache of the Italian Embassy in Washington, Professor Claudio Orzalesi. The conference was presided over by the director of the University of Naples' Institute of Aerodynamics, Professor Luigi G. Napolitano.

## Italy's Participation in Space Projects Reported

### Cassini Mission

91MI0091A Rome SPAZIO INFORMAZIONI  
in Italian 31 Oct 90 p 7

[Text] The European Space Agency (ESA) recently selected the scientific experiments that will be placed aboard the Huygens probe of the European-American Cassini mission to study Saturn and its moon, Titan. One of the experiments will be Italian: It is called Atmospheric Structure Instrument and was designed by Professor Marcello Fulchignoni, professor of the physics



of the solar system at the Institute of Astronomy of the First University of Rome. It will be used to measure the temperature and atmospheric pressure, winds, turbulence, and electricity of Titan's atmosphere. The University of Kent, the Astronomic Observatory of Meudon (Paris), the ESA's ESTEC [European Space Research and Technology Center] Center, and the Finnish Meteorological Institute will also contribute to the experiment which is funded by the ASI (Italian Space Agency). The Cassini/Huygens probe will be launched with a Titan-IV/Centaur carrier from Cape Canaveral in 1996.

### **Hermes Space Shuttle**

91MI0091B Rome SPAZIO INFORMAZIONI  
in Italian 7-14 Nov 90 p 5

[Text] The French company Dassault has recently commissioned Aermacchi of Varese with the development of a new scale model of the European space shuttle Hermes that will be used for wind tunnel aerodynamic tests. The order, which currently involves one model but could be extended to another one or two models, follows that for the supply of the first three models (in 1:40 scale) designed and then developed by Aermacchi with numerical control systems. The Italian company, is also working on the production of the fireproof bulkheads for the Viking engines of the Ariane 4 carrier on behalf of the French company SEP [European Propulsion Company]. These initiatives could be a sign of Aermacchi's increased involvement in European and Italian space activities.

### **Italy's Role in Aerospace, Civil Aviation Programs Reported**

#### **Synthetic Aperture Radar**

91MI0116A Rome SPAZIO INFORMAZIONI  
in Italian 21 Nov 90 p 4

[Text] The Consortium for the Research and Development of Advanced Remote Sensors (CORISTA) in Naples recently organized the SAR (Synthetic Aperture Radar) testing campaign with funds allocated by the Italian Space Agency (ASI). SAR is designed for the remote sensing of the earth's surface, in preparation for future activities associated with the Italian-German X-SAR program and launch of the European ERS-1 [European Remote Sensing] satellite in April 1991. A Convair-580 aircraft, manufactured by the Canadian company Intera, with two C and X band SARs aboard was used for this campaign, called SAR-580. The aircraft flew over the Matera area, Vesuvius, the Lipari islands, the Marmolada, and Venice (at an altitude of approximately 6,000 meters), and collected a considerable amount of scientific data. ASI and CORISTA have already established a program of activities for the future. The program provides for a number of experiments using a NASA DC8 aircraft with other SAR equipment aboard, scheduled to arrive in Italy in summer 1991.

### **Airbus Wings**

91MI0116B Milan ITALIA OGGI in Italian 30 Nov 90  
p 39

[Text] Mandelli's flexible manufacturing systems from Piacenza will build the Airbus wings. The Emilia-based company, one of the leaders in the field of factory automation, has recently reached an agreement valued at more than 5 million European currency units [ECU] with the French group Aerospatiale, the leading European helicopter manufacturer. The agreement involves the supply of a highly sophisticated integrated system of machining centers, robots, and automated machinery. The system will be installed in the Meaulte plant, in the French region of Somme and will manufacture all the light alloy parts for the wing structures of the Airbus range. Mandelli's flexible manufacturing systems can perform 130 different operations using more than 500 tools.

This order is of crucial importance for the Italian company, because it allows Mandelli to both strengthen its position on the French market, which currently accounts for 20 percent of its turnover, and to penetrate into an expanding sector.

### **Fokker Involvement in Ariane Construction Noted**

91AN0081 Rijswijk POLYTECHNISCH WEEKBLAD  
in Dutch 1 Nov 90 p 7

[Article: "Fokker Signs Multimillion-Guilder Contract for Ariane Rocket Parts"]

[Text] Fokker Space & Systems (FSS) has been commissioned by the French aerospace concern Aerospatiale to supply parts for the European Ariane 4 and Ariane 5 rockets worth 160 million Dutch guilders. In addition, Aerospatiale has placed an option with FSS worth another 30 million guilders. Fokker is also to produce parts for the Ariane 4 rocket for the German companies Messerschmitt-Boelkow-Blohm (MBB) and ERNO for a total of 11 million guilders.

The contract between FSS and Aerospatiale concerns parts for 50 Ariane 4 rockets, more specifically, the connecting rings between the first and second, and the second and third stages. Fokker is also to develop the engine frame for the Ariane 5. Ariane 5, which is still in the design phase, is scheduled to fly in the mid-1990s. FSS will build nine engine frames: six for ground tests and three for tests in space. These two orders represent 90 and 70 million guilders, respectively.

In addition, FSS expects to reach an agreement with the French regarding a system to recover Ariane's auxiliary rockets. This system should make it possible for jettisoned boosters to make a soft landing so that they can be recovered and eventually used again.

Finally, Fokker has signed a contract with MBB/ERNO for the production of 96 nose cones for Ariane 4.

**Contractor**

The Ariane series is being developed under the auspices of the European Space Agency (ESA) and is marketed by Arianespace, which commercializes Ariane. Arianespace consists of a number of large European industries (such as Aerospatiale and MBB) and operates as main contractor for the various Ariane programs. FSS is a subcontractor that in turn may subcontract project parts to other suppliers. For the recent FSS/Ariane order, Fokker subcontracted the wind tunnel experiments to the Dutch National Air and Space Laboratory (NLR), while part of the design work is to be done by Stork Product Engineering in Amsterdam. Other subcontractors have been given to Fokker Special Products Hoozeveld (connecting structure and engine frame), the Rotterdamsche Droogdok Maatschappij [Rotterdam Dry Docks Company] (lathe work for intermediate rings) and Polymarin (nose cone and separation shield).

**AUTOMOTIVE INDUSTRY****France: Peugeot Launches Electric Car**

91WS0075A Paris LE MONDE in French 5 Dec 90  
pp 1, 24

[Article by Veronique Maurus: "A Real Start for the Electric Car: Peugeot Introduces an Assembly-Line Van Costing 30 Percent More Than the Gasoline-Engine Model"]

[Text]

It is a small white van with blue markings that looks just like the ones all over the streets of Paris, except for two details: It works on electricity and sells for a catalog price of 130,000 French francs. This is the big event of the 10th international electric vehicle exposition being held in Hong Kong.

For the first time ever, a major automobile manufacturer—Peugeot, actually—is marketing an electric vehicle that is mass-produced on the same assembly lines as its classic counterpart and only 30 percent more expensive. An immediate success: EDF [a French Power Company] has already ordered 250, Hong Kong's China Light and Power Company about 50, and Austria 25. Negotiations are under way with some 15 French cities (Dunkirk, etc.) and the principality of Monaco, a dozen European countries, the PTT [posts, telegraph and telephone], Eurotunnel, major corporations, etc.

No doubt about it: After 20 years of faltering and disappointments, the electric vehicle is finally here. No more weird prototypes and random experimentation. After the utilitarian model, which is sold at a higher price to a special clientele, Peugeot has announced that in 1994 it will introduce an electric 205 for the public that will sell for the same price as its gasoline-powered counterpart. Then, by the turn of the century, a separate model. The Americans, with General Motors in the lead,

will begin standard production model marketing within two years, and the Japanese in three...possibly with some surprises.

Executives from the China Light and Power Company explain, "At the age of 92, our chairman still attends board meetings. In each meeting, he asks, 'When will we introduce an electric vehicle?' Until now, we were unable to find an automaker to sell them. This time, there is one: this is for real. We'd like to make half of our fleet electric in the very near future."

Why this sudden craze after so many years of setbacks? The answer is twofold: environment and oil crisis. Ecological concerns, which long remained a secondary consideration, have taken on such political impact that they are now among the priorities of all decision-makers. Pollution-free, totally noiseless, and above all not too fast—100 km/hr at the most—and therefore safe, the electric vehicle is the ideal choice for urban transport. The State of California recently kicked off the trend by requiring automakers to sell at least 3 percent electric vehicles by 1998 (and at least 10 percent by 2003). Regulations should follow suit everywhere, ultimately making city-polluting thermal vehicles purely and simply illegal.

The Gulf crisis, while accenting the vulnerability of oil-consuming countries in the face of the whims of Middle Eastern oil, also helped speed things along. In fact, although replacement methods do exist for the production of primary energy (nuclear, coal, gas, hydraulics, etc.), transportation is still just as dependent as it was on black gold. Here, too, the electric vehicle appears in the end to be one of the only viable solutions.

So there is already a potential market. All the more so because the idea of a limited-use town-car, usually a second car, is rapidly developing. Peugeot has calculated that by 1995 the European market for small-engine second cars covering no more than 70 miles a day will reach 400,000 units (instead of today's 300,000). Half that total could be electric.

All that remains is to capture that market, which will not be easy because electric vehicles have two major handicaps: Limited range and a high price-tag. On the technical level, considerable progress has been made in the past 20 years. The highest-performing vehicles now have a range of 100 kilometers, batteries are sealed, recharging time is no more than 10 hours, and the maximum speed can be up to 100 km/hr.

The above are the typical requirements for a car that can travel around town for an average of four hours a day and be recharged at night through a simple electrical outlet. But the technical revolution expected in the area of batteries, where weight and size are major handicaps, is still not here. As for price, until now it has been greatly excessive. Since there was no mass production, prototypes, although numerous, were no more than a conversation piece.

These handicaps should progressively be eliminated. By fitting the electric motor to assembly-line models, Peugeot has proven that the cost gap can be reduced to an acceptable level for highly-motivated organizations such as cities, power companies, administrative services, etc., especially because the cost of running these electric vehicles is much lower. At La Rochelle, where for several years now the city has been using electric vehicles produced locally by Volta using components purchased from major automakers, the utilities manager feels that the excess initial investment is amortized within 3 years due to the practically inexistent maintenance costs and especially the low cost of the fuel. At the night-time power rate, an electric vehicle costs only 6 to 10 francs per 100 kilometers of travel, in contrast to an average of 50 francs for a gasoline-powered vehicle.

#### Peugeot's Voluntary Policy

Peugeot believes that three or four years down the road the price gap will disappear. The increase in mass-produced units, up to at least 50,000 vehicles per year, should cut the cost of the engine, battery, and electronic control systems in half. Within 10 years, the production of a separate model could even bring the price down below that of thermal vehicles, thereby reversing the problem.

"We have adopted a voluntary policy to break the vicious circle," explains Jean-Yves Helmer, manager of PSA's automobile division, adding "Until now, electric cars didn't sell because of the high price, and the prices were high because they didn't sell."

#### Voluntary But Not Deluded

Even at Peugeot, a pioneer in the field, no one ever thought electric vehicles would replace all gasoline-powered vehicles overnight. Since practically no headway has been made in the field of highway vehicles—although numerous versions exist...on paper—the electric car will be limited for a long time to specific, essentially urban, uses. But experts think that by the beginning of the next century 10 to 15 percent of the world market could be driving electric. Quite tempting for EDF, which is already designing collective charging systems in garages, beside parking meters, and even...in gas stations!

#### Peugeot, Renault Modernize Production

91WS0048B Paris INDUSTRIES ET TECHNIQUES  
in French Oct 90 pp 64-68, 71

[Article by Michel Alberganti: "Two Great Challenges: Peugeot and Renault"]

[Text] In addition to being the largest French industrial site, with its 23,000 workers, the Sochaux Peugeot production center is also one of the biggest private plants in Europe. The monumental task of renovating Sochaux will come to an end in 1994, having transformed a

cluster of aging factories into a showcase of high technology capable of producing 1,850 average and top-of-the-line cars a day. Now midway through the renovation, the program has already consumed 5 billion French francs [Fr]. Another four billion will be necessary to successfully complete this industrial adventure centered around three perfectly articulated elements: people, technique, and relations with suppliers.

Begun in 1986, the undertaking began with...the diversion of a river—the Allan River—which added 11.6 hectares of land. The lot now houses two new units, painting and soft trimming. The first unit, which will be doubled in size in 1992, is a veritable laboratory protected from all outside contamination. The figures tell the story better than any long speech: 30,000 square meters of clean room (no particle bigger than 3 microns to be found), 15,000 fire detection and sprinkler heads, and 280 programmable automatons topped off by 43 consoles and three computers. Some 108 mini-bowls, 40 multi-axis robots and 36 robot arms can paint round the clock, up to 1,850 bodies a day, virtually without human intervention.

Innovations are in evidence everywhere you turn and are a permanent challenge to Lion engineers. An example: the first-time-ever use on an industrial scale of the foundry "disposable pattern" process. Or the automation of the sheet-rolling mill, essential to insure faultless geometry of the assembled bodies. The two versatile sheet-rolling shops are kept going by 166 flexible presses. The first, which includes 200 robots, manufactures 1,230 vehicles (405s) a day, while the second, started up for the 605, features 91 robots and delivers 500 cars an hour.

Not far from there, another immense building in high-tech architectural style has gone up. The plant, used for soft-trimming of the vehicles, will be doubled in 1991 when another hall with identical productive capacity is added. The entire establishment will take final shape in 1994-1995, when a new assembly plant for putting together the soft-trimmed bodies and the mechanics will be built. Here, the effort to automate is combined with a concern for ergonomics. Very high-speed automated areas alternate with manual operations, where the line doubles back on itself and the rate slows. Another original feature: To facilitate assembly, the cars, which are painted with their doors on, have the latter removed on entering the shop and will not have them reattached until the end of the line.

"Our whole operation is based on the idea of tight flows, which in a few years will be the norm in all Sochaux production plants," stresses Claude Dudouet, director of the logistics mission. Here too, the challenge is formidable. It consists of nothing less than extending the concept of just-in-time (JIT), that is, ordering the delivery of parts and subassemblies from outside suppliers as they are needed for production, to the entire plant. It is a working method that demands an enormous logistical effort and the establishment of relations of

trust between the manufacturer and his subcontractors, promoted to "partner" status.

Already the painting facility is stocked daily following JIT by two suppliers who are fully responsible for the quality of their products. The soft-trim shop also operates on this flexible tight-flow concept. As is the case for painting, the trucks come to a large unloading zone on the main floor and parts arrive directly at their point of use, without passing through the classic warehouse. The key to this is a substantial reduction in parts under manufacture and a remarkable optimization of the production flow by simplifying handling channels. In a sense, stocks are shifted to suppliers, who must provide a cushion of parts equal to the factory's peak daily consumption. In counterpart, the maker's stock has melted like snow in the desert heat: On average, stocks no longer exceed eight days, including parts for cars under assembly.

As far as Claude Dudouet is concerned, setting up a JIT manufacturing operation on this scale is a long-term proposition. For it implies more frequent deliveries—from four to 10 daily, even more depending on the equipment—and above all unfailing quality. The incoming parts must be able to be used immediately without inspection on receipt. "To achieve this, we are constructing a virtual automobile-manufacturing hub linking production with all of our partners." Thus, whether they are established in Normandy or the edge of the Atlantic, suppliers whose products are used at the start of final assembly build beachheads near the Sochaux center to insure JIT delivery under optimal conditions.

Training, mandatory for one and all, plays a vital role in such an undertaking. Over 600,000 hours a year are spent on training...a sizeable continuing education operation.

#### **Boxed Material: C. Dudouet, Peugeot**

"Schedules, quality, and personalization...are the three imperatives of automobile production," explains Claude Dudouet, director of the logistics mission in Peugeot Ltd. They are also the three locomotives of just-in-time Peugeot-style: "The point is to optimize industrial flows, which implies working both on managing the flow inside the factory—the question should be settled by 1992—and on organizing our relations with some 900 outside suppliers, an undertaking that should continue until 1994. Our goal is to bring the delivery time of cars to dealers down from 31 to 18 calendar days, while giving them a greater choice of models."

#### **Renault**

Just five years ago, the recommended solution for shortening development cycles was to swap drawing boards for CAD [computer aided design] work stations and extend the computer connection to manufacturing. Having tried it, Renault, a pioneer in the matter, has concluded that although CAD is a major weapon in

improving quality, it has little effect on the time required to develop a car. Renault assigned the "Time Reduction" problem to Patrick Le Quement, director of industrial design. No miracle solutions, mind you, just some partial answers combined with a profound change in organization. Some of the ideas, in particular the Project Group notion, were applied to the design and engineering of Clio. "The sequential structure of Engineering and Design must be broken down and replaced with a matrix organization in which the different steps are submitted to the arbitration of a group whose work intersects. The latter, the Project Group, combines the people in charge of Product, Manufacturing, and Service, and coordinates all steps: preliminary plan, prototyping, pilot stage, preproduction runs, and marketing. It is placed under a project director." Philippe Bourguignon fills that role for Clio, surrounded by the heads of quality control, design and engineering, purchasing, manufacturing, and marketing. In Japan, Toyota has been using the concept successfully for 25 years. At Renault, the idea has been germinating since the first intersecting groups, synthesis and contract groups in charge of project coherence and feasibility respectively, were set up. Jean-Pierre Verollet, director of chassis systems, remarks: "Design and Engineering is on the average working on three or four projects simultaneously. At any given time, they can be working on a new model and three additional versions of existing models. In addition, there is considerable shifting around of personnel between projects and divisions and sudden spurts in activity: 150 people in the preliminary planning phase, then 700 people in design and engineering, and still more in manufacturing. Moreover, as the project progresses, there is a geographical dispersion of the teams. All these factors justify having a coordinating group, assigned to one project and one project only. Such a group was set up for the R19 back in 1986. Its function was to monitor the coherence of the work of different groups, but also to be an advocate of the Purchasing and Methods departments, until then brought in too late in the game. With Clio, the group has moved to the center stage. It guides the entire project and arbitrates conflicts between management and automaking professionals (priorities, distribution of resources, technical choices and costs). It gives the go-ahead on assembly, manufacturing, and marketing agreements."

Patrick Le Quement also wants to increase the importance of the exploratory phase of the project. "When Japanese manufacturers quote their development time, they are careful to omit this preparatory phase. It is of crucial importance, because that is when the great technological choices are made and when problems are detected at the earliest point. In Japan, this preparatory work is done with the greatest of care: That is why the commencement of design and engineering properly speaking is so quick.... There is no more shuttling back and forth, no more questioning of the project, no more obstacles." These remarks are expanded upon by Jean-Pierre Verollet. "If one compares the process of developing a vehicle to a growth mechanism, it is during this



upstream phase that the genetic material is elaborated. All errors made at the genesis of the project seriously compromise the final quality and can only be compensated for at the cost of great efforts. These errors will resurface at some point, in the worst case, during marketing." But isn't the purpose of numerical calculation techniques, whose use is becoming systematic in the design and engineering department, precisely to spy out these flaws? "Not exactly. Calculations are used to optimize a solution that is fundamentally sound, not to detect design errors. They greatly speed up test/correction iterations, but cannot in any way eliminate a structural flaw." At Renault, the preliminary study group now has a strong organization. Division heads who until now met only occasionally will be gathered together in Saint Quentin-en-Yvelines. They include the directors of operations, design and engineering, purchasing, methods...but also the best specialists in engines, chassis's, car bodies.... The group will gather information from all sources, particularly the marketing network, and through it, the customer. "Different vehicle components have very different lifespans. Car bodies are redesigned for each new version, in contrast to a chassis or engine which are made to last 10 years. If the beginning of a design study is not synchronized with validation of a new design for a front transmission, we will be forced to use the previous model. Thereby losing 10 years of technological progress. The solution is long-term planning of preliminary studies."

#### **Boxed Material: P. Le Quement, Renault**

"All the efforts made so far to improve quality have been made at the expense of development time, which has risen from 50 to 60, even 65, months. Our goal is to bring it back down to 45 months." Patrick Le Quement, head of industrial design, is in charge of the Renault project to shorten design cycles. What methods does he envisage? "First of all, reorganizing design and engineering studies around a project director who ensures the continuity, coherence, and leadership of a project from start to finish. Japanese carmakers adopted this form of organization long ago. What's more, it is a return to our beginnings in the automobile industry, with highly personal projects and very close teams."

#### **European Applications of Automation, Robotics Reviewed**

91WS0048A Paris INDUSTRIES ET TECHNIQUES  
in French Oct 90 pp 58-60

[Article by special correspondent Mirel Scherer: "Going All Out on Automation"]

[Text] European manufacturers are seeking their salvation in an all-out effort to automate. Volkswagen in Emden, Renault in Flins, PSA in Sochaux and, especially, Fiat in Cassino, to name only those companies, are pulling off technological feats armed with robots and computers. The explanation for this trend can be

summed up simply: the need to meet Japanese competition by optimizing productivity, flexibility, and quality. It is a sweeping program...

In Emden, Passat's stronghold, a thousand vehicles a day roll off the assembly lines bound for Europe, the United States, or Canada. As with all the other manufacturers, the plant was completely revamped before the new model was brought out in April of 1988. It was a monumental project which affected more than 80 percent of the shops (auto body, assembly, painting, sheet rolling, logistics) and cost 1.2 billion German marks over three years (1988-1990). Automation was the motto! No fewer than 500 robots operate in the factory. An example: parts adjustment, performed by a few clamping robots driven by a specialized software program. The same robotized ballet plays out under the attentive eye of the computer on the auto-body assembly floor. Tasks are divided among the 32 robots which line up the parts, the six robots which join the folded seams of the sheet metal, and the six robots which weld the 400 welding spots. The auto bodies are carried to different stations in wire-guided cars, an approach used by other makers, such as Fiat in Cassino. Periodically, one of the cars laden with a welded body trundles over to the Bravo three-dimensional measuring machine, for a tolerance check that catches slippage in the automated installations at the earliest possible moment. There are also four robotized stations for geometric mounting, a technical solution that is beginning to win converts (Renault uses it in Flins to make the Clio). Another sector being automated is painting. Over a hundred automated installations will begin applying water-soluble paint to the vehicles sometime between now and the end of 1990. The Germans are thus taking the lead in preventing solvent-pollution. But Citroen's painting line in Rennes is also designed for water-soluble paint: an investment of 1,200 million French francs [Fr].

The Cassino factory, the pride of Fiat, is used as a benchmark of automation, which Italian engineers have pushed to the absolute limit. Their equipment is impressive: 609 supervisory and management computers, 399 robots, 24 lasers, 59 television setups, 481 wire-guided cars.... The whole of this small world communicates through a local large-band network, in contact with the central facility in Turin. The factory makes the Tipo, but has been remodeled to manufacture the new car launched by the Turin maker, the Tempra. A wholly automated stamping shop, avant-gard sheet rolling and painting facilities, many final assembly operations done without human intervention: Nothing has been overlooked. Based on the principle of zero defects, the factory uses robots for tasks as varied as mounting of wheels, seats, and mechanical components, bonding, screwing, and painting.... Such an approach was facilitated by taking automation into account as early as the design stage. Each part of the car was the object of a detailed study to reduce the number of components, mark specific wiring and reference points, and accurately define dimensional tolerances. One example among

others are the screws which were completely revamped so that the 175 screw insertions performed during mounting of the mechanical parts on the frame could be automated. This operation reaches new peaks of automation: 10 robots screw on the bottom of the frame, two others attach the forward suspension from above, assisted by a last robot which lifts the frame. The front and rear bumper sets, the four wheels, and the spare tire are mounted at the 12 stations, equipped with 24 robots served by 45 wire-guided cars which select the first free station. Two programmable systems (magnetic and radio wave) are in place to identify the parts depending on the car model being made. That is how the supervisory computer controls the progress of work in real time. Quality control—a veritable obsession—is reinforced at every step. In the iron shop, three measuring devices with opto-electronic sensors mount the guard, after welding of the front part of the chassis and frame. Six points of the front armature are checked by laser and 16 points by post-process system. The five Macs (automated checking machines) are responsible for checking the other dimensions or geometric dimensions while the car is on the line. The machines, which can be programmed according to the amount of deviation in the measurements, are equipped with one or two arms. Painted surfaces are also inspected using a closed-circuit television system designed by the Fiat research center. All this information is transmitted to the "Giove" central quality-control system (Zeus, or computerized management of vehicle orders). The latter determines, based on production orders communicated by the Turin central computer, the daily schedule that is possible and the gaps between forecasts and actual production, controls the progress of production, and so on. Other achievements are worth mentioning, such as mass production of the rear door in duroplastic in under two minutes, machining of the pontoons on two robotized islands (2,800 parts in 16 hours), laser welding of the front armature, or Comau's Robogate swing-tray system, able to be integrated into Smart robots.

It is hard today to do better than Fiat. However, French manufacturers have also embarked on a frenzy of automation and have adopted certain methods used at Cassino. In Sochaux, Peugeot has built an automated line for the 605 on which assembly of the instrument panel/pedal works set is fully automated. The painting unit has also reached a pinnacle: 108 mini-bowls, 40 multi-axis robots and 36 robot arms paint 1,850 bodies a day, round the clock, nearly autonomously. Another technique borrowed here is robotized mounting and bonding of the windshield. The very ambitious modernization plan of the Sochaux factory (see report page 64) aims to become (sic) the most advanced center of the French automobile industry. In Flins, Renault did not neglect automation when it launched Clio. Renault Automation grabbed the lion's share of the work, but other companies (Cerema, GTIE Automated Production, SGIE Industry, etc.) contributed to the modernization effort. However, Renault reused already existing systems for the R5, "which saved a billion francs" says

Pierre Leperchey, assistant director of the factory. It is a tidy sum, considering the total industrial investment devoted to Clio: Fr3.56 billion. A similar sum was spent on bringing out the R19. No fewer than 220 robots work at Flins on the two production lines which alternate between making the Super 5 and Clio, each at the rate of 60 cars an hour. The assembly time for the Clio will ultimately be reduced from 18 to 16 hours. It was 21 hours for the R21 in 1987 and 25 hours for the R14 in 1980. In Japan, Nissan assembles its Bluebird and Maxima models in 18 hours. European makers are thus somewhat advanced in this respect. The plant, which has been operating on tight flows since 1987, is organized into functional production units (FPU) responsible for their work. The same approach is used for the sheet-rolling mill, 99-percent automated. Sophistication often means increased maintenance, but in Flins robot dependability is 99.5 percent per robot and 95 percent per manufacturing island.

#### **Boxed Material: Volkswagen**

"In Emden, automation goes hand in hand with reorganization of logistical flows and management," says Hans-Wilhelm Wildeboer, a member of the factory's management team. "Our plan," he says, "rests on two pillars. First, the creation of a modern supply center, with automated warehouses. Second, the establishment in 1987 of a just-in-time system. Parts are ordered only six hours before manufacture is begun. Just-in-time is already in operation for two components of the Passat: the gas tanks furnished as needed by the Kautex Company, located 30 kilometers from Emden, and the front and rear bumper assemblies delivered by Peguform, a company located 80 kilometers from the factory."

### **BIOTECHNOLOGY**

#### **France Joins International Human Genome Research Effort**

##### **National Program Launched**

91WS0044A Paris LE MONDE 19 Oct 90 p 12

[Article by Catherine Vincent: "Mr. Curien Launches a National Research Program on the Human Genome"; first paragraph is LE MONDE introduction]

[Text] Mr. Hubert Curien, minister of research and technology, announced during the Wednesday 17 October cabinet meeting that a national program of research on the human genome would be launched (see our 18 October late editions). In so doing, France is stepping up its participation in the great biological adventure, orchestrated by the United States, of fully mapping the human genetic inheritance over the next decade.

"To reach critical mass, the genome program must reach a spending level of another 100 million French francs [Fr] a year before 1992," Mr. Curien announced. This

will nearly double the French budget for the colossal research project over the next two years. One hundred and fifty million French francs were already spent on it in 1990, 100 million of them footed by public organizations (two-thirds for staff expenditures, one-third for operating costs).<sup>1</sup>

The international Human Genome project, expected to last 15 years and cost an estimated 3 billion dollars (over Fr15 billion), is still essentially overseen by its initiators in the United States. Under the aegis of the National Institute of Health (NIH) and the department of energy, the American program includes an initial five-year phase funded at 200 billion dollars (over Fr1 billion) a year. The goal is to decrypt, chromosome by chromosome, the 50,000 genes and 3 billion genetic traits that define our species (4 October 1989 LE MONDE).

Ultimately, researchers hope to be able to understand and detect, even prevent, thousands of hereditary diseases (3,000 have been inventoried to date) and to acquire a formidable working-stock for studying the molecular mechanisms of life. Even though some researchers, worried about the magnitude of the budget required, still consider the project outsized, others counter with the assertion that, given recent findings in molecular biology, "a hundred of the most frequent genetic diseases will be able to be studied in the next five years."

#### Too-Isolated Researchers

In France, several public laboratories have already set out on this race for knowledge, which currently occupies over 500 researchers, engineers, and technicians. But their work, Mr. Curien stresses, "is still too limited and scattered to stand up against international competition." France's position thus looks more fragile than Great Britain's, which was able, with spare financial resources (Fr110 million for the next three years), to organize effective and competitive research in the field.

"To participate fully in what is becoming an international scientific project, France has decided to launch a research program to coordinate and strengthen the work of the public laboratories already in the race," Mr. Curien said. A specialized public interest group (GIP) will be formed for that purpose and will be accorded the budget increase announced by minister of research (Fr50 million in 1991, 100 million in 1992.) The autonomous organization will have an administrative and a scientific board and will be responsible for "coordinating research orientations" and "allocating new funds appropriated by government authorities."

The final, and not least, mission of the future Human Genome GIP (public consortium) will be to set up real cooperation with other countries, starting with the United States. The latter is not prepared to share the results of its research unless there is real international collaboration, both technical and financial, on the project.

#### Footnotes

1. And not a total of Fr9 million, as mistakenly indicated in our 18 October final editions.

#### Research Described

91WS0044B Paris LE MONDE in French  
24 Oct 90 p 20

[Article by Catherine Vincent: "France's Genome": "France Picks Its Method for Mapping the Register of Human Genes"]

[Text] By announcing the start up of a national research program on the human genome (19 October LE MONDE), Mr. Hubert Curien, minister of research and technology, undoubtedly reassured the sixty or so laboratories in France already sporting the word "genome" in their research titles.

Their work, which consists of mapping the entire genetic inheritance of the human species over the next decade, now has three new aces: a very respectable budget (Fr200 million in 1991, 250 million in 1992), a public consortium (GIP) for coordinating all research, and a real scientific policy. The American precursors of the international "Human Genome" project selected the most ambitious, expensive, and lengthy method: full sequencing of human DNA. Lacking equal resources, France has now opted for a more pragmatic formula: genetic mapping.

The nucleus of a cell, picked at random among the 100 billion that make up a human being, contains 23 pairs of chromosomes, each composed of a long molecule twisted around itself in the shape of a double helix: DNA (deoxyribonucleic acid), is the base material of our genetic heritage.

#### A "Biological Apollo"

Unrolled and lined up end to end, the 23 molecules form a DNA string over one meter long, in which the four chemical units that determine the genetic message—the G (guanine), C (cytosine), A (adenine), and T (thymine) bases—successively alternate. The total comes to three and a half million bases, declined with an alphabet of four letters, whose "sequence" forms the words—the genes—characteristic of the human species.

That is what sequencing means: decoding from one end to the other the links of that chain of life to determine the exact order of the bases that compose it. A register big enough to fill 2,000 volumes running 500 pages each and to mobilize nearly 10,000 people full time for 10 years....

It is a wild, grandiose project, a "biological Apollo" as colossal as the United States, which did not wince at investing a budget of 200 million dollars (over Fr1 billion) a year for an initial five-year phase. Confronted with such outsize ambition, what could France do to remain in the international competition?

Lacking the heavy-duty equipment installed the United States (automated DNA sequencers, computerized data-management systems), sequencing appeared out of reach. Relying on research already conducted by molecular biologists, France has, therefore, opted for a less systematic, but just as essential, approach: mapping the hundreds of thousands of genes contained by human chromosomes.

True, at first sight the two approaches seem very similar. Yet the difference is enormous. Of the 3.5 billion bases linked to each other along our DNA, only 5 to 10 percent make up the genes, that is the genetic sequences that the cellular machinery will translate into proteins. The role of the remaining 90 to 95 percent of DNA is essentially unknown.

By deliberately opting for gene mapping, French human genome research has selected a strategy that is complementary to the American method, less costly, and richer in immediate therapeutic repercussions. Of the 50 thousand genes man possesses for living and reproducing, 2,000 have so far been pinpointed on our chromosomes. The tools of molecular biology already make it possible to use some to prenatally diagnose serious hereditary diseases such as muscoviscidosis, myopathy, or thalassemia. Others help detect the probability of contracting complex pathologies such as diabetes, multiple sclerosis, certain cancers, and rheumatisms.

### Three Thousand Genetic Diseases

Besides those few examples, 3,000 human diseases have now been counted involving, more or less directly, genetic defects: 3,000 afflictions whose diagnosis and treatment are still difficult, if not impossible, for lack of knowledge about the location and nature of the genes involved. This gives some idea of the promise that full mapping of human genes holds for biologists and physicians.

Now it must be decided how French research, faced with such an unprecedented challenge, will be organized. With a comfortable budget and researchers, engineers and technicians already numbering over 500, it is still relatively disorganized, a quality that does not lend itself to the coordination of such a huge undertaking. Comparison with North American or British laboratories working in the field "cruelly highlights the ponderousness of French organizations,"<sup>1</sup> says Bertrand Jordan, head of the human molecular genetics group at the Marseille-Luminy Immunology Center (CNRS-INSERM [National Center for Scientific Research/National Health and Medical Research Institute]). It will be up to the recently created "Human Genome" GIP to give new impetus to France's overly scattered research, failing which France will eventually be outstripped by its European partners.

In this international race whose stakes are still incalculable, France's main asset today is the accumulated findings of the Center for Human Polymorphism Study (CEPH). The organization was created in Paris in 1984

by professor Jean Dausset, 1980 Nobel prizewinner in medicine, and seeks to discover the genes involved in hereditary diseases. It centralizes the most studied human DNA data bank in the world: an irreplaceable genetic treasure, compiled from 800 individuals belonging to 60 exceptionally large families.

Used as reference material by 70 laboratories in the world, these DNA banks should make it possible to significantly speed up drawing of the human genetic map. "With 2,000 genes located, 25 percent of the work is already behind us," says Daniel Cohen, vice president of the CEPH. "Ten thousand markers would be enough to locate, through recurrence, any sequence of interest to human genetics."

The CEPH, which is already 50-percent funded by the Ministry of Research (Fr20 million a year) and has semi-industrial equipment, should also play a dominant role in drafting the European "Labimap 2001" project. The latter plans, in coming years, to develop and market a system of automatons capable of performing the excruciatingly complex operations involved in molecular biology.

### Footnotes

1. MEDICINES/SCIENCES No 8, October, 1990

### Germany: BMFT Announces Monoclonal Antibody Research

91MI0094 Bonn TECHNOLOGIE-NACHRICHTEN  
MANAGEMENT-INFORMATIONEN in German  
14 Nov 90 p 5

[German Federal Ministry of Research and Technology announcement of funding for research and development projects on "Production of Human Monoclonal Antibodies," dated 15 October 1990]

[Text] As part of the "Applied Biology and Biotechnology" program, the Federal Ministry of Research and Technology [BMFT] will subsidize R&D projects that help solve methodological and technical problems that currently exist in the production of human monoclonal antibodies.

The objective is to make routine production of human monoclonal antibodies possible in the future.

Subsidies will be provided for projects that use the principles of cellular biology in methodological and technical research and development work on the following topics and problems:

- In vitro immunization of human B-lymphocytes;
- Immobilization of human B-lymphocytes through fusion with suitable partner cells or through transfection in order to produce stable, highly productive cell lines;
- Induction of affinity enhancement of human monoclonal antibodies produced in vitro;



- Induction of a class-switch in the human B-cell lines for the production of high-affinity IgG antibodies;
- Long-term culture of human B-cells, e.g., by improving B-cell proliferation and improving the selection processes and enrichment methods;
- Optimization of production methods by improving the fermentation technology and by drawing up serum-free mass culture methods for antibody-producing cells.

In addition to R&D projects based on the conventional hybridoma technique, subsidies will also be granted for projects that take up and extend existing research on the application of genetic engineering methods to produce human monoclonal antibodies. These include:

- The formulation of methods for producing what are known as "humanized" monoclonal antibodies, which consist predominantly of human protein sequences;
- The production of human monoclonal antibodies in human and nonhuman expression systems by genetic engineering methods;
- The production of high-affinity antibodies or antibody fragments through "site-directed mutagenesis."

As a rule, the research and development projects should be carried out as joint projects involving both state and industrial facilities. Subsidies will be granted for projects that are in the public interest and involve a considerable technological and scientific risk.

A project can be subsidized only if it is fully described and substantiated by the applicant, if the applicant possesses the appropriate qualifications and has the necessary capacity to carry out projects of the type described in the application, if the financial requirements are met and the applicant's accounting system is capable of proving that state funds have been properly used, and if the project will be carried out and [the results] exploited in the Federal Republic of Germany.

As a rule, funding will take the form of subsidies and will also require that the recipient of the subsidy should contribute part of the costs; industrial concerns must bear at least 50 percent themselves. Projects in the region of the former GDR may be granted a subsidy 10 percent higher (than would otherwise have been allocated).

The conditions for Federal Minister of Research and Technology subsidies to industrial concerns are given in the Collateral Regulations for Cost-Based Subsidies Granted to Private Industry by the Federal Ministry of Research and Technology for Research and Development Projects. The BMFT Special Collateral Regulations on Expense-Based Project Funding shall apply in principle to other applicants.

Applications for project funding should be addressed to: Project Manager for Biology, Energy and Ecology Juelich Research Center (KFA) GmbH P.O. Box 19 13 5170 Juelich 1 (Tel. 0 24 61/61/55 43)

Application forms, instructions and the administrative rules referred to above may be obtained from the project manager. It is advisable to contact the project manager before submitting an application to discuss the planned work program on the basis of a short working paper.

Bonn, 15 October 1990

The Federal Minister of Research and Technology By order Dr. Warmuth

#### **Germany: BMFT Subsidizes R&D On Monoclonal Antibodies, Biosensors**

*91MI0105 Graefelfing BIOENGINEERING FORSCHUNG & PRAXIS in German No 5, 1990 p 12*

[Text] The Federal Ministry of Research and Technology [BMFT] is funding the development of biosensors (BMFT Biosensor Technology Subsidy Program, dated 10 June 1988) within its "Applied Biology and Biotechnology" program. Developments in areas of application of particular significance for present and future public welfare receive priority support from the BMFT.

Priority is thus being accorded to the development of biosensors for drug detection as a contribution to the Federal Government's antidrug plan. The Federal Criminal Office has been examining various ways in which biosensors can be used for drug detection thanks to their ability to measure low concentrations in the gas phase. They could, for example, lead to the detection of drugs during transport.

Biosensors exploit the ability of biological systems (e.g., antibodies, receptors, enzymes, microorganisms) to detect substances in low concentrations with high selectivity. In biosensors, these detection systems are connected to measuring instruments through signal converters.

As a rule, research and development projects must be carried out as joint initiatives involving public and industrial bodies. Participation in joint projects is also open to GDR research institutes.

Projects eligible for funding must be of public interest and involve a high technical and scientific risk.

A project will not be eligible for funding unless it is duly described and justified by the applicant, the applicant has the required technical qualifications and capabilities to carry out the project for which funding is requested, his or her assets have been ascertained, the applicant's accounting system ensures adequate documentation of federal fund usage, and the project is carried out and the results exploited in Germany. Usually, projects are funded through subsidies, which are granted on condition that the beneficiary contributes to the cost of the project. Commercial enterprises must contribute at least 50 percent of the cost. The conditions underlying the allocation of funds to industrial enterprises by the Federal Ministry of Research and Technology are laid down in the "Collateral Provisions Governing Cost-Based

Grants Awarded to Industrial Companies by the Federal Ministry of Research Technology for Research and Development Projects" (NKFT 88). Grants to other applicants are regulated by the "Special BMFT Collateral Provisions for Expenditure-Based Project Funding" (ANBest-P- BMFT).

Applications for project funding should be addressed to:

Biology, Energy, und Ecology Project Management KFA  
Juelich GmbH P.O. Box 19 13 5170 Juelich 1 (Tel.  
02461/61/5543)

## COMPUTERS

### Germany: Juelich Center Simulates Neural Networks

91MI0096 Bon *TECHNOLOGIE-NACHRICHTEN*  
*MANAGEMENT-INFORMATIONEN in German*  
14 Nov 90 pp 7-8

[Text] A world record was recently established by Dr. Gregory Kohring at the High Performance Computer Center in the Juelich Research Center (KFA): the simulation of neural networks with 100 billion couplings per second, calculated on the CRAY Y-MP 832 high performance computer. A whole year's programming work has thus been crowned with success.

Neurons are nerve cells in the central nervous system. The human brain has about 1 trillion ( $10^{15}$ ) interlinked neurons.

The first part of Dr. Kohring's work entailed a comparison between theory and experiment. Neural networks are an attempt to understand animal and human brain functions by studying the collective (common) behavior of all the neurons in the brain. This is in contrast with the traditional biological approach, which focuses on the significance of the individual neuron. With neural networks, the individual neuron loses importance just as the individual gas molecule does in kinetic gas theory.

In view of this similarity, it is not surprising that theorists have attempted to use mathematical processes to study simple functions such as associative memory (based on idea linking). However, even the simplest model is so complex that only approximate solutions can be found.

The Juelich program simulated the neural system of up to 100,000 neurons and 10,000,000 links between the neurons. Systems of this size had to be studied to obtain a clear picture of how far the approximate mathematical solutions lacked physical principles and associative memory attributes. With regard to the links between neurons, this system was 900 times larger than any previous experiment.

The second part of the study involved the search for the most effective method of creating neural networks in the

light of the stage currently reached in computer engineering. Dr. Kohring used the Willshaw model, in which the neurons and their links are assigned values of 0 and 1 only, as opposed to the Hopfield model with its real numerical values. This model is thus ideally suited to present-day computer engineering.

Simulation speeds of up to 164,000,000,000 link evaluations per second were achieved using multispin coding. In comparison, simulations of other models achieved only 500,000,000 link evaluations per second.

These results are a very encouraging step toward the creation of artificial neural networks.

### Italy: Hospital Develops Computerized X-Ray System

91MI0089 Milan *ITALIA OGGI in Italian*  
13 Nov 90 p 44

[Article by Daniela Calamia: "X-Rays From Computer Printers"]

[Text] Farewell old digital film. Yesterday, for the first time in the world, a laser printer "turned out" an X-ray using data obtained from a CPU mainframe. This took place in the radiology department of Bologna's Maggiore hospital, which is directed by Professor Sandro Sartori Galloni. From now on, therefore, a patient will not need to carry his medical file consisting of X-rays and written diagnoses when he is transferred from one ward to another. The patient may even remain in his ward while a specialist from another hospital examines his X-rays to better decide on the therapy. In fact, it would be better to speak of "screen displays" since the doctor has a series of terminals in front of him which are connected to a data base that provides the information needed for a diagnosis.

The image that appears on the screen substitutes the one previously on film. The advantage is that details of the image can be enlarged and the contrast increased or decreased to optimize analyses and eliminate the super imposition of organs that are not of interest. The digital radiology and telematics equipment at the Maggiore hospital was inaugurated yesterday after two years' experimentation. The system for managing, filing, and transmitting digital images (PACS) operates through a CPU mainframe that is capable of handling 10.8 GBytes of information (AT&T-Philips computer connected to a Kodak laser printer). The Sant'Orsola and Bellaria hospitals in Bologna are already connected to Maggiore's "big brain."

Information is routed via on optical fibers both inside and outside the "trauma center." The total cost to date is 4 billion lire.

The example in Bologna is not an isolated one. The Ferrara hospital is also about to inaugurate a similar department. An attempt is being made to carry out an in-depth evaluation of the progress of new technologies,

How the System Works



Key: 1. Diagnosis Unit—2. Digital Radiology—3. Optical Network—4. Cat—5. CPU Mainframe—6. Optical Data Base—7. Workstations—8. Radiology—9. Laser Digitalizer—10. Digital Fluoroscopy—11. Hospital Information System

their clinical impact, and the advantages in using these in terms of management and diagnosis at the first international conference on digital radiology and PACS which ends today. Sartoni Galloni emphasized: "PACS still needs to be structured for medical use. This complex system needs to be continuously modified even from a conceptual point of view. Although digital radiography is already a reality, the information transmission system can become reliable only after a trial period of no less than three years."

However, this is not the only thing needed. In Italy for example, the digitalized filing of images has no legal status. This could be a major obstacle to modernizing hospital structures together with a certain generational resistance from doctors who are still tied to the traditional radiological film.

Images of gastroenterological and nephro-urological diagnoses, cholangiography, and senography are currently available in analog form because of the unavailability of a technology that is sufficiently reliable for diagnostic purposes.

#### UK Institute Develops Portable Supercomputer

91AN0102 Edam SUPERCOMPUTER EUROPEAN WATCH in English Oct 90 pp 13-14

[Text] UK's Royal Signals and Radar Establishment (RSRE) introduced a high-performance computer with

the "size and weight similar to a ream of typing paper." This machine, dubbed "Mousetrap," offers minisuper-computer performance in a hand-held package. Mouse-trap can sustain 200 Mips and 25 Mflop/s and consumes only 40 watts of power. Its "guts" (without military casing and optional rechargeable battery pack) weighs a mere 2 kg. Its overall dimensions are 28 cm x 25 cm x 12 cm and it contains a 12.5 cm color LCD display, together with a key panel enabling users to key in data and execute algorithms. External connections may be made to additional display devices and peripherals.

Mousetrap is based on the same architecture as the Parsys Supernode 1000 Series. The name goes back to the original ESPRIT [European Strategic Program for Research and Development in Information Technologies] project, when a prototype was called Reconfigurable Array of Transputers (RAT) cage. A mouse is a kind of "shrunk rat" and the Mousetrap a shrunk Supernode; instead of common circuit boards, ceramic substrates are used. The system is intended, initially, for defence-related compute-intensive field applications in rugged circumstances—although it could be made available for many other applications in commerce and industry. Indeed, consumer applications, e.g., in the oil industry and in radio transmission, are being considered, since Mousetrap easily outperforms even the most sophisticated hand-held systems currently available.

Situated in Malvern, RSRE is the UK Ministry of Defence's main center for research and development in electronics and computing. RSRE had recognized for many years the potential importance of parallel processing and has had an active research program in the area since 1980. In a major ESPRIT-backed project which began in 1985, Parsys and RSRE collaborated with others to design what became the Supernode architecture and the Immos T800 transputer.

Mousetrap was shown in Wembley at Milcomp Europe '90 during the last week of September, in a joint marketing exercise by Parsys Ltd and RSRE. The aim of this exercise was to see how the market would respond and Parsys officials claim a very favorable response.

Commented David Watson, managing director of Parsys: "We have cooperated with RSRE on a number of projects but this is certainly one of the most exciting projects to date. RSRE have repackaged the Supernode architecture for hand-held operation—and in so doing they have opened up a whole new area of potential applications.

## ENERGY

### Germany: Pile Driving System for Deep-Sea Drilling Developed

91MI0098 Bonn *TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN* in German 14 Nov 90 p 15

[Text] Natural gas and petroleum extraction from deposits under the seabed is advancing into increasingly deeper waters. In order to attach the necessary technical equipment solidly to the seabed at depths of 1,000 or more meters, piles must be driven into the substrata of the seabed to a depth of up to 100 meters. A ramming system has been developed for this purpose and successfully tested in the Gulf of Mexico. The Federal Ministry of Research and Technology (BMFT) funded this development by a medium-sized German company in view of the project's high technical and economic risks, and provided a federal grant of approximately 440,000 German marks for deep-sea field trials, without which the system could not subsequently be marketed.

After the requisite preliminary trials on a test pile in the relatively flat Baltic Sea to prove functional viability, the equipment was shipped to Morgan City, Louisiana and prepared for use on a working ship on the open sea in the Gulf of Mexico. The approximately 90-meters long test pile was then driven about 100 meters into the seabed in water about 1,000 meters deep, a task performed without problems in a few days.

Now that the trial has been successfully run, an as yet unrivaled system and process for deep-water pile-driving is available. It will be of increasing economic significance for opening up new natural gas and petroleum

deposits under the sea and has established a new milestone in international offshore engineering, achieving a competitive advantage for a German marine engineering company.

Further information is available from Mr. H. Kuehn, Menck GmbH, P.O. Box 11 65, 2086 Ellerau, tel. 04106-70020

## FACTORY AUTOMATION, ROBOTICS

### Germany: Advanced Robot Component Project Completed

91MI0080 Bonn *WISSENSCHAFT WIRTSCHAFT POLITIK* in German 14 Nov 90 p 7

[Text] Sixteen firms and institutes have cooperated in a joint project on components for advanced robot and handling systems, for which the Federal Ministry of Research and Technology (BMFT) has provided 5.4 million German marks [DM] over five years. The project involves research and development studies on five priority areas [that include] control, [words omitted in original text] drive systems, innovative kinematics, and special measurement systems for industrial robots. The project on concepts basic to large-scale mobile robots sets out to combine the technological capabilities of industrial robots and manipulators in a single system. As a first step, the Fraunhofer Institute of Manufacturing Engineering and Automation (IPA) in Stuttgart and the Karlsruhe Nuclear Research Center carried out an operational study. Possible applications would include laying concrete with a concrete pump, treating concrete surfaces, maintaining and repairing building facades and bridges, etc. On completion of the project, several new products were introduced by the participating firms and institutes. Among them was a robot for cleaning aircraft, which obviates the need to build the extremely expensive washing hangers for each type of aircraft. The second is used for repairing ships' hulls. This robot travels, guided by sensors, over curved surfaces carrying heavy machines such as steel-blasting equipment or paint sprayers, supplying and disposing of working materials at the same time. A third robot will assist in the repair of leaking sewers.

### Germany: Cray Supercomputer Used in Machine Tool Industry

90WS0059A Duesseldorf *VDI NACHRICHTEN* in German 12 Oct 90 p 35

[Article by Konrad Buck: "Supercomputer Optimizes and Tests Complex Process Technology"; first two paragraphs are VDI NACHRICHTEN introduction]

[Text] Moench-Gladbach, 12 Oct (VDI-N)—Computer simulation helps in the further development of tube rolling mills. FRG machinery manufacturers and American computer manufacturers have concluded a pilot project.



The use of computers on the workshop floor is no longer rare. However, the fact that the development of tube rolling mills is planned, optimized, and tested on computers by process engineers is tantamount to a revolution. Developmental engineers can now build on computer results instead of empirical values as they formerly did.

The potentials of process optimization in the machinery manufacturing industry were limited in the past in a large part to tests in production and model systems. For the rest, developmental engineers simply based their work on their experience and so-called "rules of thumb" for estimating metal forming values.

Such methods include some disadvantages such as high experimental costs for the leasing of entire rolling mills for test purposes. Additionally, significant problems arise when individual parameters need to be investigated separately. This increases the investment risks of both the manufacturer and the customer and also stands in the way of systematic optimization of metal forming processes and entire rolling mill systems.

To eliminate such uncertainties, Mannesmann Demag Huettentechnik [metallurgical technology] and the American computer manufacturer Cray Research have introduced process simulation of tube forming processes as a modern aid in application technology. It was first necessary at the beginning of the project to create a practical software concept. The basic point of departure was the issue of how it would be possible to simulate forming processes through a mathematical model so that they could be observed all the way through the various stages of production. For this, prior identification and avoidance of critical operations in each production phase was considered necessary.

The ultimate objective was a complete process simulation environment combining both planning and product testing functions and thus delivering significantly more accurate results. "We wanted to use the PC in a hands-on computer-assisted simulation process," reports Peter Thieven, who deals with technical calculations in the Mannesmann Demag group MEER in Moenchengladbach. "We wanted to create a problem solving machine for the technical specialist with which he could design and improve the rolling mill from the process technology side."

The fact that the participants in the project were breaking new ground with this venture and were reaching and even passing beyond the former frontiers of what was technically feasible constituted a special challenge to all those involved. Because, the precalculations alone required more than 200 hours of computer time on the world's largest supercomputer, a Cray Y-MP. One program run for a simulation takes between four and 50 hours.

It was possible to turn to existing finite-element programs for sci-tech calculations. Furthermore, in Abacom

of Aachen and Marc Deutschland of Munich, two companies were found who are currently the leading suppliers in this market. The resulting software packages, items with a development time of approximately one hundred man-years, were already created during the 1970's and have been supported continuously ever since. It is only with the current task definitions that a supercomputer can really bring its enormous computing power into play. The hardware platform includes one workstation each in Moenchengladbach, Munich, and Minneapolis. The last two are linked to each other by high-speed datacom and have on-line access to a Cray Y-MP. Data records for simulation calculations created and tested in Moenchengladbach were forwarded to Munich, transferred by satellite to Minneapolis, and processed on the Cray Y-MP there with the FEM [finite-element method] programs. The results obtained in the United States were either analyzed by the project participants there or the raw data were sent back to Moenchengladbach and evaluated here.

Meanwhile, in Minneapolis the first complete production simulations ran. They led to noteworthy results: They provided near-reality simulations and demonstrated that the fundamental work for the design of a computerized process simulation environment had been accomplished. The calculation models are now available, have been tested, and have proven their worth. The coordination of the various codes for analysis, visualization, and evaluation is working.

One optically appealing secondary effect is the 3-D color visualization of the results. The revolutionary thing about the images generated with this is that they are the direct final results of extremely complex calculations. Thus, tubes display the same deformations found in parallel practical experiments in the rolling mill. However, even more significant than the colorful images is the advantage compared to conventional experiments: Numerical simulation permits accurate investigation of rolling process using detailed intermediate results which can be called up at any time.

"Visualization of the results is also the best method of monitoring them. The images produced and the video films of the simulated tube rolling process now available are an excellent match for the processes observed in reality," acknowledges Cray employee Axel Krapoth.

Ralf Passmann, manager for technical calculation at Mannesmann Demag MEER, also expresses optimism: "Project results are so good that Mannesmann Demag Huettentechnik has decided to base the processing tests of new tube rolling mills on numerical simulation methods as much as possible, with conventional tests used only for verification of the computed solutions."

In the future, the engineer will enter the parameters with which the "computerized rolling process" is supposed to run into an input mask, and an immediate dry run will take place in the form of bits and bytes. According to Thieven: "We can rework the simulation program for

every possible type of process. With our new system, field testing of cold pilger rolling, continuous rolling, and stretch reducing on the screen no longer present any problems." Krapoth describes the results as a "quantum leap" in forming technology, comparable to the introduction of crash simulations in the automobile industry.

Now the conditions at the contact surface between the roller and the tube can be analyzed, especially in difficult to investigate production in rolling lines. Formerly, the essential measurement points were simply not accessible. In contrast, in simulation, mechanical factors such as stresses, elongations, and deformation conditions affecting the tubing are calculated in specific steps at each instant as a function of external loads.

Krapoth sums up the process as follows: "We are making phenomena which are hidden in reality visible through technical means. When a simulation has been calculated through to the end, it can be observed, analyzed, and differentiated from every angle." What are the results for Mannesmann technical specialists? They can deliver production systems with which tube products can be produced faster, more cost-effectively, and with higher precision than was formerly the case. Thus, the Moench-Gladbach firm has obtained a new performance profile. The traditional machinery manufacturer has also become the supplier of high technology production processes.

To be able to use the technical capabilities quickly, Krapoth is publicizing the model of the "calculation workstation connected to a regionally available supercomputer" developed with Mannesmann. The Cray employee sees the PC on the desk of every developer connected to the evaluation unit of a supercomputer and integrated into a high performance network. His vision: a PC—a personal Cray.

#### **Japanese Engineers Automate Italian Company**

91MI0120 Milan *ITALIA OGGI* in Italian  
1-2 Dec 90 p 44

[Article by Carlo Arcari: "Japanese Robots Conquer Piedmont"]

[Text] The Japanese are among us and are taking over strategic positions by attacking the very heart of Italy's advanced industrial system with the help of the most innovative Italian companies.

This was demonstrated in the case of Sandretto, a Fornara group company that manufactures injection presses for plastic materials. It called in engineers from Mazak, the Japanese machine tool giant, to build its new 40-billion lire automated plant in Grugliasco [near Turin].

Japanese technology is taking over all of Europe—computers, electronic equipment, automobiles, high definition television, and electronic components. Only one high technology sector in Italy seemed to be sufficiently

protected from the "Japanese danger": "factory automation" a sector in which Italian manufacturers are certainly able to compete on the world market. However, even this certainty is now a matter of discussion since Japanese robots are beating national competition right here, in Italy's "technocity" only a few steps away from well-known robot factories such as Comau and Elsag.

How could this happen? Were there no Italian manufacturers capable of building such a plant? "Not many European suppliers are able to offer a complete hardware and software turn-key solution that is really workable for our sector," observed Luigi Visconti, general manager of Sandretto, a company with 1,200 employees, seven factories, and a turnover of 280 billion lire in 1989. Visconti continued: "Italian companies could have constructed the plant we wanted but none of these factory automation manufacturers were able to meet all our requirements at a moderate price, their solutions were either too expensive or with little integration. We wanted a really 'automatic' factory, from work planning to the finished product which only Mazak could guarantee."

Sandretto's objective was to increase its output from 800 presses in 1985 to 1,800 in 1990. For this reason a new plant was constructed to manufacture "strategic" components with a just-in-time approach, that is eliminating inventory and maximizing flexibility.

The Grugliasco plant manufactures the 100 most "strategic" components of the approximately 1,000 components of Sandretto presses. This is done in five fully automated production lines with machining centers and lathes. Robots handle parts and tools needed in the manufacturing process. The lines also include washing machines and measuring centers for quality production control.

"The pieces are already tested and ready for assembly when they come off the production lines," stated Visconti, "all with 80 workers. The plant, which was inaugurated last spring, currently manufactures 1,500 presses a year but with slight modifications production could easily reach 2,500 units."

The industrial automation of the plant cost about 25 billion lire. Mazak supplied machine tools, robots, as well as operations and monitoring software. Digital supplied its Microvax computers and the local area network for line and plant integration.

#### **Italian Company Develops Robot for Aluminum Foundries**

91MI0149 Milan *ITALIA OGGI* in Italian  
19 Dec 90 p 44

[Text] The main objectives of Apollo, a multifunctional robot that is designed to change anodes in electrolytic cells, are to remedy the environmental hazards of aluminum factories and increase adaptability to the manufacturing process.

The prototype, which was presented yesterday at Techmo Car's headquarters in Limena, permits operating times to be reduced since it can be adapted to various types of systems. In fact, its lightness permits it to be assembled and integrated on any type of ore bridge, even those with a limited range.

The project was recognized to be highly innovative by the Ministry of Industry. One year ago, Techmo Car was granted 1.1 billion lire in funding at favorable interest rates under Law 46/1982, corresponding to 55 percent of the project's costs. The government's increased awareness of the environment was certainly a decisive factor in singling out this initiative, but not the only one. Under a technological profile, Techmo Car's project is a break with the past. The self-propelled machinery and equipment suspended on ore bridges, which were used to change the anode prior to Apollo, were rigid structures that could only be adapted to the manufacturing processes they were designed for. Furthermore, the procedure was lengthy because once the substance was removed, it first had to be transferred to the appropriate storage area, where the new anode was retrieved. The electrolytic cell, which emitted fumes, often remained open for more than 10 minutes. On the contrary, Apollo contains the new anode even before the cell is cleaned and is opportunely driven by a programmed system that completes the entire operation in just one minute.

The new system can also be easily transported from one place to another within the factory. In case of a breakdown, it does not halt production since it can be immediately removed. There is no problem for the operator either, who can maneuver the robot from the inside of a booth that is insulated from the external environment with special soundproofing systems and filters.

This prototype is Techmo Car's latest development. The company was established in 1960 by its current president Franco Zannini, to design and develop manufacturing equipment for the primary aluminum industry. The Techmo Engineering company has also been established primarily to meet with international competition and will collaborate with other international companies on the modernization of systems. Apart from Apollo, Techmo Car is currently working on the DAISY (Dry Absorption Integrated System) project. This system is designed to eliminate highly polluting emissions resulting from the production of aluminum, starting with fluoron. Already patented in the principal aluminum producing countries, DAISY will probably be developed before the end of 1991.

## **LASERS, SENSORS, OPTICS**

### **German Research Ministry Funds Laser Engineering Program**

91MI0131 Duesseldorf *HANDELSBLATT* in German  
12 Dec 90 p B2

[Text] It is not just in medical engineering that laser technology has gained increasing significance in the last

few years. This decidedly young technology is acquiring a constantly increasing range of applications, particularly in materials processing. To make it safe for man to handle the beamed light, the Federal Ministry of Research and Technology (BMFT) has earmarked a specific portion of the research subsidy funds budgeted for its Laser Engineering subsidy program for projects that set out to investigate safety at work.

Over the last few years several pilot laser engineering projects have clearly shown that knowledge of the dangers inherent in the handling of lasers is inadequate. These gaps in our knowledge, however, apply less to electrical and/or optical safety in the use of lasers—the FRG is at the forefront in having a multitude of provisions, such as those embodied in the professional trade association regulations on laser safety.

### **Emission Hazard Largely Unexplored**

The main area where knowledge is scarce is the hazard potential inherent in the emission of gases, vapors, and aerosols when heat is involved in the use of lasers. The research projects carried out to date have addressed only a small fraction of the questions that need answering. They must, therefore, be followed by studies that take account of the classes of materials used, such as high-alloy steels, plastics, and composites, and the different laser applications, such as cutting, bonding, and surface treatment. New retention techniques, such as filters to prevent dust particles from entering the lungs, must also be developed. About 7 million German marks has consequently been budgeted for job safety within the Laser Research and Laser Engineering subsidy program. These funds will have to last for about three years.

It is intended to attach special importance in future to studying and standardizing diagnosis and assessment methods. International coordination and definition of standards and safety regulations will be of primary importance in this respect. The single European market effective 1 January 1993 is already requiring special efforts in this direction on the part of science and industry.

### **Cooperation Between Industry and Science Required**

The Eureka [European Research Coordination Agency] Technology Program provides a flexible framework for the drafting of common standards and safety regulations. One example is a network formed by a wide range of joint projects between laser science and the laser industry that has grown up in the Eureka member states in recent years. The conditions are therefore right for mastering laser safety relatively quickly, to the benefit of those who have to work with lasers every day.

The BMFT believes that the same applies to preliminary standards. By now these have assumed European dimensions in research and technology policies: Under Eureka, common industrial standards feature as "supportive measures" in the Eureka Declaration of Principle of 5/6 November 1985. At the suggestion of the FRG research

minister in his capacity as president of the Council of Research Ministers, the Commission of the European Community included preliminary standards in EC research policy as well in 1988. Work on laser safety will be undertaken from the outset in Eureka in close coordination with the Eurolaser projects already in progress.

The planned subsidy measures are closely linked with the Labor and Technology subsidy program. They will also contribute to a constant reduction in the need for remedial improvements in working conditions and the achievement of a more humane and user-friendly technology environment. In the specific case of protection against emissions during the use of lasers, improvements in the protection of operators on the shop floor must not entail greater environmental pollution. The planned research work will also make a concrete contribution to technology impact assessment in laser engineering.

#### **Eureka Industrial Forum on Laser Safety**

Experts from 17 European states convened in Hannover in late October for the Eureka Industrial Forum on Laser Safety. This forum serves two purposes. Firstly, it gives scientists from Europe an opportunity for an objective treatment and discussion of this complex subject, and secondly, it offers all those attending an opportunity to work on the concrete definition and organization of international cooperation on laser safety within Eureka. The industrial forum was also attended by scientists from the five new FRG Lands and from East Europe (Poland, USSR).

The work that has been in progress in the FRG since the beginning of this year in preparation for international cooperation within Eureka has revealed two main topics that may well also lead to two new Eureka projects. The first is an investigation of pollutant emission during thermal material processing with lasers, and the second is additional basic research that will contribute a deeper understanding of the technology, for example, a study of the dose-to-effect ratio in laser medicine to ensure safe use for both patient and therapist.

#### **PTT Funds Cologne Fiber Optic Media Park**

91MI0137 Duesseldorf *HANDELSBLATT* in German  
14-15 Dec 90 p 22

[Text] Deutsche Bundespost (DBP) Telekom plans to install an ultramodern fiber optic telecommunications infrastructure in the grounds of the Cologne Media Park.

In the view of DBP-Telekom managing director Gerd Tenzer, an involvement on the site, which was formerly a freight yard, makes sense because "reasonable use will be made of the broadband network there for the first time." This network is designed to facilitate communications for the companies based in the Media Park, where the available options will include faster data transfer and the exchange of images and films via optical fibers. Services such as telephone, telefax, radio, and television will also be supplied via optical fibers. During an interview in Bonn,

Tenzer praised the project as "a showcase for telecommunications applications of the future."

The DBP company will install cables, exchanges, and network terminals in Cologne. Tenzer hopes that "we shall be able to keep our investment below 10 million German marks." Contracts have not yet been awarded, however.

For Tenzer, the Media Park venture is one of several pilot projects involving fiber optic systems in Germany. A total of seven projects is planned: two in Cologne, and one each in Frankfurt-on-Main, Lippetal, Leipzig, Nuernberg, and Bremen. Tenzer says that the pilot projects will serve to develop a fiber optic system to serial production level. Only for such large production runs of network infrastructure equipment, such as digital-to-analog converters, would prices reach a level at which this technology could reasonably be used on a broad base.

Tenzer wants to arrive at European standards governing the use of fiber optic networks to supply broadband services as soon as possible. He will hold talks with the European standards authority ETSI [European Telecommunications Standards Institute] in the next few weeks, and he plans to form a working party in Berlin to draft specifications for network terminal components and terminal equipment.

#### **German R&D in Micro-Optics Outlined**

91MI0139 Duesseldorf *HANDELSBLATT* in German  
19 Dec 90 p 24

[Article by Dr. Peter Bley of Karlsruhe Nuclear Research Center's Institute of Microstructure Engineering: "Producing Three Dimensional Structures"]

[Excerpt] [Passage omitted] The Karlsruhe Nuclear Research Center has developed what is known as the Liga process as an alternative to silicon micromechanics. The term derives from the three processing stages, synchrotron radiation lithography (deep X-ray lithography [Roentgentiefenlithographie]), electroforming [Galvanoformung], and casting [Abformung] with plastics. This process can be used to produce three-dimensional structures in any given lateral geometry, several hundred micrometers tall, and with minimum dimensions in the micrometer range. Metals, metal alloys, plastics, and ceramics may be used as materials. Over the past year, the process has been further developed at the Institute of Microstructure Engineering to a point where even free-moving microstructures can be made.

Developments began in the early eighties in connection with nuclear engineering studies with a view to producing extremely small nozzles for uranium enrichment. In the meantime, a large number of new potential applications for the Liga process have been developed. The Liga prototypes currently under development include components for sensors and actuators, microoptics and integrated optics, chemical and medical engineering, and biotechnology.



The MicroParts company is exploiting the Liga process commercially; it was founded by Hoesch, Huels, Rheinmetall, Steag, and VEW [United Electricity Works of Westphalia] in August 1990. A microstructure engineering center that will manufacture Liga structures on an industrial scale and require investments of about 50 million German marks [DM] will be set up in Dortmund with grants from the city and the Land of North-Rhine Westphalia. We shall now look briefly at the main steps involved in the Liga manufacturing process and a few samples illustrating its potential uses.

In the first phase of the Liga process a 100-micrometer thick plastic layer, known as a resist, is exposed to X-rays via a mask. The rays are emitted by a synchrotron, a machine in which very fast-moving "relativistic" electrons are propelled by magnets. The magnets are arranged in such a way that the electrons circulate in a ring. If the electrons are deflected, however, they emit electromagnetic radiation, which may extend into the "hard" X-ray range for high electron energies and small deflection radii. The synchrotron also gives high energy density and very good beam parallelism. A precise copy of the mask can thus be reproduced in very thick resist layers from the shadow that it casts.

The radiation absorbed in the resist triggers chemical changes such as bridging between the long plastic molecules, and the exposed areas can, therefore, be dissolved away with a suitable developer, leaving the unexposed areas as they were. An initial tridimensional plastic microstructure is thus obtained.

A metallic microstructure can be produced by electroplating the spaces in the initial plastic microstructure with metal. Electrolytic deposition of the metal commences at the base of the structures on an electrically conductive base plate, to which the resist is applied prior to irradiation. The unexposed resist is removed, leaving an initial metallic microstructure complementary to the plastic structure. Special electrolytes and the associated composition and impurity analysis procedures had to be developed to ensure impeccable deposition of the metals in the channels, many of which are very small and narrow. Various electrolytes for nickel, copper, and gold are currently being successfully tested.

The metallic microstructure can also be used as a matrix for secondary casting by injection or reaction molding to manufacture microstructures in various plastics in large production runs and at relatively low cost. These may either be the final product or serve as molds for another electroplating process to mass produce metallic microstructures. Microstructures in various ceramic materials have also been produced using the slip casting process to fill the plastic structures. The plastic mold decomposes without residue when the ceramics are fired.

Micro-optics represents a large area of application for plastic microstructures. Since the resist used in deep X-ray lithography (PMMA = polymethyl methacrylate, trade name "Plexiglass") is optically transparent, the structures

produced by deep X-ray lithography can be used directly as optical components. It is thus possible to manufacture micro-optical benches with prisms, cylinder lenses, beam splitters, and so on, the individual components being manufactured in a single production phase on a suitable substrate and matching one another with high precision.

Structuring the resist as a sandwich of several slightly different polymers will result in light conduction in the intermediate layer only. Planar waveguides can therefore be produced in any shape (Y junctions, branch points, etc.). A grating spectrograph with an autofocus reflection grating was developed as a complex micro-optics component (6 mm x 18 mm). The curvature of the grating and/or each one of the 1,200 grating teeth is given precisely the optimum calculated shape, and the plastic grid is vapor-plated with gold to make it reflective.

Light is fed into this component via an optical fiber, the grating disperses the light, and the spectral components of the light are focused on several output fibers. These optical fibers are embedded in precisely fitting grooves produced directly when the component is manufactured. Basically the component can be used as a multiplexer/demultiplexer in optical communications or as a microspectrometer. The spectrometer made to date operates in the long-wave visible spectrum and or/the near infrared region. Work is under way to extend the range of application to shorter wavelengths.

Filters for the far infrared region may be regarded as typical examples of metallic microstructures. Band-pass filters admitting only a narrow spectral range consist of a thin metal membrane with a specific slot pattern such as crosses or Y-shapes. The critical dimensions amount to only a few micrometers, and the membrane thickness is between two and 30 micrometers. High-pass filters admitting only short-wave radiation may consist of an alveolar metal mesh, for example. High-pass and band-pass filters produced by the Liga process and successfully tested have been installed in the ESA (European Space Agency) ISO [Infrared Space Observatory] project's photometer and are scheduled to go into orbit to survey remote stars in 1993.

Free-moving microstructures have been produced according to the Liga process by building up Liga structures on disposable layers. The stationary parts of the microstructure are built up directly on a base plate and the mobile parts on an intermediate layer. The disposable layers between the microstructure and the base plate are selectively removed at the end of the manufacturing process.

Initial examples of moving microstructures of this type, which are still under development, are acceleration sensors, microsprings for securing optical fibers, and micro-turbines. The smallest turbines manufactured to date with the Liga process have a diameter of 130 micrometers (about double that of a hair) and a thickness of 150 micrometers. The blades and bearings can be of any shape, for instance curved blades and an axle with a grooved cross section.

Very quiet running and long working periods were achieved with extremely small bearing clearances of about three micrometers by creating air cushions. Work is underway on using these microturbines as volumetric flow meters for very small gas flows; high-precision adjusting devices for optical components are being manufactured directly using the turbine production process. These microturbines, which are activated by a gas flow, also form the preliminary stage for electrically driven microturbines.

Other Liga components are being developed in addition to those briefly described above; they include, to list but a few: coils, linear induction motors, valves, particle filters, various positioning devices, gearwheels, fluidic elements, spinnerets, plug-in connections, and so on, terms that should all be prefixed by "micro." The following fields may be regarded as potential markets for Liga products: automobile engineering, precision mechanics, computer engineering, optics, chemical engineering, metrology and analysis, medicine and biotechnology, environment engineering, textile engineering, aerospace, and basic research.

In principle Liga components can be integrated directly on silicon chips with finished, integrated circuits by both deep X-ray lithography and casting methods. Development work has only just begun, however. A combination of the Liga method with conventional silicon micromechanics may well extend the area of application.

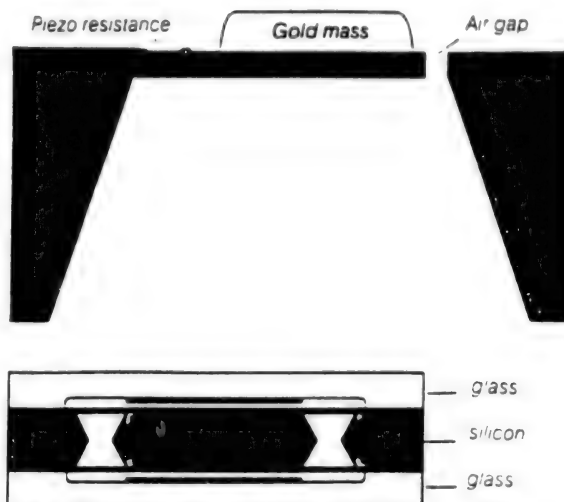
The Liga process not only makes it possible to manufacture high-precision microstructures as single units by deep X-ray lithography and electroplating. The casting techniques developed provide the potential for manufacturing microstructure in various materials cheaply and in long runs. The efficacy of the Liga process developed in Germany has meanwhile been acknowledged worldwide. Development work on the Liga process has begun in the United States and Japan as well.

Germany still has a clear lead in this new technology. This lead must be maintained or increased by further intensive research work and by transferring the development results promptly to industry. As the investment that both the development work and the build-up to industrial production entail is high, further public funding is essential to the success of this novel technology.

#### Germany: MBB Develops Acceleration Sensors

91MI0141 Munich MBB NEW-TECH NEWS  
in English No 3, 1990 pp 13-15

[Excerpt] [Passage omitted] Solid-state piezoresistive and capacitive acceleration sensors are the first fruits to be borne by MBB's relatively young Microsystems Technology Department. In making these components, the company's developers and production technologists have not only taken another significant step in the direction of sensor miniaturization, but at the same time



Cross section and view from above a capacitive acceleration sensor. A mass is suspended on eight thinner-than-hair silicon threads. When the sensor is subjected to acceleration, the mass resists due to its inertia and the relative movement alters the capacitance of the sensor. Recesses and a counterelectrode are incorporated in the thin glass cover platelets.

successfully entered the promising fields of micromechanics and microsystems technology. The new sensors are intended primarily for applications in motor-vehicle electronics, and will be produced in MBB's Nabern plant, near Stuttgart.

The most widespread micromechanical components include pressure sensors of various types that have already been available in large quantities for years. The simplest of micromechanical devices, pressure sensors consist of a silicon substrate that for most industrial applications is thinned locally to create a membrane with a thickness of 10 to 20 micrometers. Large-area membranes with a thickness of about one micrometer are used as a mask substrates in X-ray lithography, without which it would be impossible to produce submicrometer structures.

Resistors are then diffused into the membrane. When the resistors are subjected to mechanical stress, their resistance changes due to the piezoresistive behavior of silicon and allows conclusions to be drawn about the amount of pressure bearing on the membrane. This effect is also exploited in semiconductor sensors for measuring acceleration, vibration and flow.

Particularly in the case of acceleration sensors, the focus of MBB's Microsystems Technology Department, there are two principles that may be employed: the piezoresistive or the capacitive. The heart of a piezoresistive acceleration sensor is a flexible arm approximately five to ten micrometers thick, which is etched out of a silicon substrate.

After the etching process, a gold mass about twenty micrometers thick is galvanized onto the flexible arm. Four resistors diffused into the upper side of the flexible arm are connected in the form of a Wheatstone bridge.

When the sensor is subjected to acceleration, the inertia of the gold mass galvanized onto the flexible arm resists the acceleration and exerts a mechanical force that acts on the integrated resistors to change, making it possible to pick up voltage signals corresponding to the acceleration.

Typical applications for piezoresistive acceleration sensors are in automotive electronics, where they are used to trigger the instantaneous inflation of airbags in the event of an accident. They can also be used in connection with chassis-regulation systems but in this case greater sensitivity is required (on magnitude of 2 to 5 g). It would also be conceivable to integrate piezoresistive sensors in crash recorders that constantly record the motor vehicle's path and thus facilitate the reconstruction of accidents. One of the greatest advantages of piezoresistive acceleration sensors is their extremely low price, which is order of magnitude lower than that of precision-mechanical sensors.

However, piezoresistive sensors also have disadvantages resulting from the temperature-related instability of piezoresistors—disadvantages that can be compensated only to a certain extent. For applications requiring very high precision, for instance in navigation, where resolutions of a few thousandths of the acceleration of gravity are not uncommon, piezoresistive accelerometers are unsuitable because of their temperature drift. In cases such as this, the capacitive principle may be used.

The measuring principle is also based on the idea of using a mass suspended symmetrically on thinner-than-hair silicon threads. The top and bottom sides of the mass are covered by two thin glass platelets, which have been provided with a recess and a counter electrode. When an acceleration moves the rest of the sensor relative to the suspended mass, which is also the capacitor electrode, the gap between it and the counter electrode changes, thus changing also the capacitance of the sensor. This change in capacitance of the sensor. This change in capacitance then provides an indication of the magnitude of the acceleration.

The price of the capacitive method's advantage of temperature stability is, however, somewhat more complex signal-analysis circuitry. But it is possible to integrate the analysis electronics on the same chip as the sensor in order to decrease costs yet again and to integrate as much as possible.

A completely different micromechanical structure for which MBB has already completed a prototype is an optomechanical displacement sensor originally derived

from a resonant-reed frequency meter or vibration sensor. Each of the 2,048 resonator reeds has different natural frequency and thus oscillates at a precisely defined frequency. An optical head with integrated optical waveguides is moved mechanically over the resonator reeds and irradiates them one after another. As soon as the light beam corresponds exactly to the natural frequency of a resonator reed, the reed starts to resonate. The amplitude of the oscillation is detected by a second optical fiber and passed along to analytical electronics.

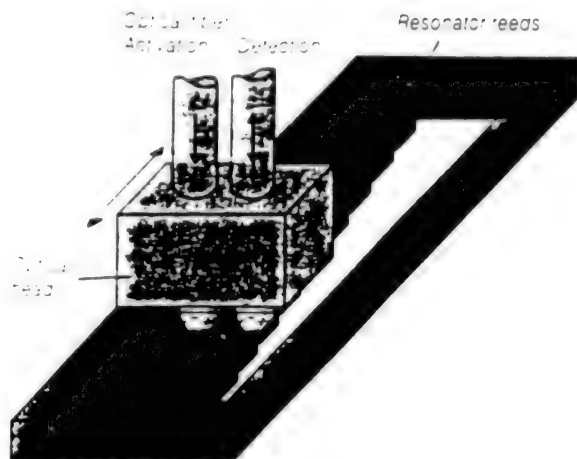
This type of sensor is interesting primarily for use in aircraft, where there has long been wish to convert to optical data communications and to "fly by light" instead of "flying by wire." An optical displacement sensor could, for example, monitor, indicate and change the positions of the aircraft's wing flaps. At present, this function is still being performed by inductive displacement sensors.

Typical examples of active micromechanical components are the microvalves and micropumps used in medical technology for extremely precise dosing (on the magnitude of microliters). Microrelays, micromotors, nozzles for ink-jet or thermal printers and movable mirrors for controlling light in laser applications round off the spectrum of active micromechanical components.

Some of the most widely known passive micromechanical components are the connectors for exactly adjusting connections between optical fibers. In addition to this already nearly "classic" example, it is possible to manufacture optical grids, elements for cooling high-performance chips with water and sieves with openings of just one micrometer. These sieves may be used in molecular biology to isolate bacteria.

All micromechanical components consist for the most part of the materials silicon and glass. This combination has become popular because glass can be bonded to silicon without adhesive in a process called anodic bonding. In this process, the two components to be bonded are heated, and a voltage is then applied to them. This causes a migration of ions, which is accompanied by powerful electrostatic forces strong enough to press the pieces together and cause the two materials to create quasi chemical bonds.

The development of this bonding process was prompted chiefly by the idea of integration—the wish to combine different individual micromechanical components with an integrated circuit to create genuine microsystems. But this technique can also be used to install several micromechanical components of the same type on a single chip to produce, for example, tactile sensors for robot arms. Sensor technology would even allow the primary sensor of a system to be integrated with its analytical electronics on the same chip.



Schematic of an optical displacement sensor which could be used, for example, in aircraft to monitor and change the position of wing flaps

## MICROELECTRONICS

### EC Semiconductor Equipment Industry Analyzed

91AN0079 Paris *ELECTRONIQUE HEBDO* in French  
1 Nov 90 p 39

[Article by Frederic Fassot: "Semiconductor Equipment: Can Europe Still Seduce?"]

[Text] SGS-Thomson, Siemens, Philips, Matra MHS/Telefunken, IBM Europe: All are prepared to give preference to European equipment and materials, provided they are unquestionably comparable with world competition. Is this an elegant way to usher out European suppliers?

"Separately, you do not exist! United, you are strong," lectures Mr. Lazzari of the French Laboratory for Electronics and Information Technologies (LETI) to the European semiconductor equipment manufacturers. More than 130 persons took part in the colloquium on the situation of the European equipment and materials industry for the manufacture of semiconductors, which was held in Grenoble on 19 October within the framework of TEC'90. Organized by JEMI<sup>1</sup>, the forum gave an opportunity to the various parties concerned to express their views on the crucial issue of whether or not to support a European equipment industry. The representatives from the Joint European Submicron Silicon Initiative (JESSI) and the European Strategic Program for Research and Development in Information Technologies (ESPRIT), manufacturers based in Europe, the large European research laboratories, all defended their viewpoint on the question. A unique opportunity to gauge everyone's motivation to give effective support to a European strategic materials supply industry. According to Mr. Bruchez of the British equipment manufacturer

Electrotech, the European semiconductor equipment and materials market is distributed as follows: 15 percent to Japanese suppliers, 57 percent to the Americans, and 28 percent to the Europeans. Going into details, 17.5 percent of etching systems and 11.5 percent of wafer steppers installed in Europe are said to originate from local suppliers. At the world level, European suppliers held 4 percent of the world market in 1986, as compared to 40 percent for the Americans and 56 percent for the Japanese. Electrotech listed Europe's strong points and weaknesses for European customers: European domination in the area of silicon wafers; American domination in ion implantation; a joint American/European domination in integrated multiprocess systems; a potential American/European domination in wafer steppers; and a European weakness in packaging in the face of an overwhelming Japanese domination.

JESSI Chairman Paletto was categorical: "Without a local equipment industry, the European semiconductor industry will never achieve strategic independence from Japan. The JESSI chairman explicitly emphasized that JESSI "also involves equipment and materials."

### JESSI: 20 Equipment Projects Retained

Half of the projects adopted by JESSI cover equipment and materials (in all, about 20 projects). A believer in the three Cs (create, consolidate, cooperate), Paletto would like JESSI to contribute to a consolidation in the sectors where the Europeans have a solid reputation (PECVD, testing, wet processing, dry etching, etc.) and encourages tripartite cooperation agreements involving equipment manufacturers, users, and governments. It should be kept in mind that 15 percent of a total of 21,400 man-years (one man-year represents 250,000 European currency units) is dedicated to equipment and materials. Mr. Kamerbeek of ASM, president of JESSI's "equipment and materials" commission, confirmed that over 160 projects were submitted and 20 selected so far. Moreover, Kamerbeek announced that informal discussions were being held with the U.S. Sematech consortium to study possible cooperation agreements on a reciprocal basis. More in-depth negotiations between the two parties will take place in early December to explore the possible exchange of technical information. Lazzari insisted on the role to be played by LETI or other major European research centers (Fraunhofer, the Belgian Interuniversity Microelectronics Center (IMEC) in the development of prototypes with a view to their implementation in production. In this field, simulation is an essential tool. Mr. Griessing of Siemens, in charge of the JESSI subprogram "IC Manufacturing Science," recalled the time schedule to be maintained: prototype development by 1993, systems development and adjustment to processes by 1994, and their actual implementation in production as of 1994. Mr. Tsalas of the EC listed the EC programs in this field: ESPRIT Microelectronics 1990-1994, whose newly selected projects should start before the end of 1991, covers all the technologies (integrated power, III-V, bipolar, bipolar complementary metal-oxide semiconductor (BiCMOS), CMOS, and silicon on insulator (SOI) technologies), whereas, in his opinion,



JESSI is mainly dedicated to CMOS technology. The amount of the funds to be allocated to ESPRIT Microelectronics has not been decided yet.

Mr. Astier of SGS-Thomson said that final purchase decisions are now made at the management level. The manufacturer's policy is to streamline his purchases. This implies a decrease in the number of suppliers. SGS-Thomson concludes partnerships with key suppliers which are based on cooperation in their development programs; in exchange, the selected "happy few" must be able to supply all SGS-Thomson plants throughout the world and provide services at preferential prices. As regards its support of European industry, SGS-Thomson is participating in JESSI and ESPRIT and in several programs with equipment suppliers for the evaluation and improvement of prototypes.

#### Europe, 50 Percent of the World Market

The facts: In 1989, SGS-Thomson placed 40 percent of its orders for wafer steppers with European suppliers (against 60 percent with Japanese suppliers); these figures reach 55 percent for metal deposition systems, 20 percent for testers, 80 percent for silicon wafers, and 40 percent for integrated circuit clamps [peignes de circuits integres]. Siemens does not wish to take any chances with its production equipment which, as regards dynamic random-access memories (DRAMs), must be used on more than one generation of products. If the JESSI program pays off, Siemens believes that by 1995, European equipment manufacturers could have a dominant position in lithography, wet processing, and as suppliers of gases and critical chemical products.

Mr. Kramer of Philips explained that decisions on investments in semiconductor equipment are made at the management level. Philips has a PC-based evaluation program which calculates the price of equipment available on the market on the basis of the cost per chip or per wafer produced. The Dutch giant buys practically nothing in Japan: 60 percent of its equipment is bought in the United States and 35 percent in Europe; whereas 80 percent of its materials is European against 15 percent American.

Matra MHS/Telefunken recalled that in 1978, 81 percent of semiconductor equipment and materials were American, 10 percent Japanese, and 9 percent European. In 1988, the world market was split up as follows: 50 percent for the United States, 45 percent for Japan, and 5 percent for Europe. In decreasing order of investment costs, Matra MHS/Telefunken lists lithography, testing, dry etching, ion implantation, and deposition. Apart from ion implantation, the company believes that European industry can have its place in all these fields in the future. As regards materials (silicon, masks, and packages), Japan's leading position seems unassailable.

For its 4-Mb DRAM production plant in Sindelfingen, IBM Europe invested \$280 million in equipment, including 50 percent of European origin; \$28 million in

silicon wafers, 70 percent of which is European; and \$12 million in chemical products, 78 percent of which from European suppliers.

#### Footnote

\*JEMI: Association of French semiconductor industry suppliers. JEMI covers 95 percent of French activities in this area. The association has 33 members representing a sales figure of 1 billion French francs (Fr), which the association would like to see doubled by the year 2000 (Fr2 billion distributed as follows: 40 percent for the French market, 25 percent for the rest of Europe, and 35 percent for the rest of the world). In the long term, JEMI could be open to foreign suppliers who produce or have an R&D center in France.

#### EC: JESSI Director on Program Achievements

91AN0072 Paris *ELECTRONIQUE HEBDO* in French  
25 Oct 90 p 13

[Interview with JESSI Director Raimondo Paletto by Francoise Grosvalet: "JESSI: First Evaluation Positive"; first paragraph is *ELECTRONIQUE HEBDO* introduction]

[Text] The Joint European Submicron Silicon Initiative (JESSI), a European "success story!" Raimondo Paletto, president of the JESSI Board, the decisionmaking body of this pan-European program for the development of advanced integrated circuits, sounds confident. Eighteen months after the EUREKA green light, the results are in: Fifty-four projects are only awaiting funding by their respective governments in order to take off. Paletto, who is also vice president of SGS-Thomson Microelectronics, was quite willing to explain to us the reasons for this optimism.

**ELECTRONIQUE HEBDO:** Eighteen months after JESSI's adoption by EUREKA in Vienna, where are you with respect to your objectives?

**Paletto:** JESSI is a real success. We are far ahead of our objectives. Our Munich office, opened last October, is fully operational. During the last 12 months we have examined more than 200 projects involving more than 100 European companies and universities. Of these projects, 54 have been approved by the JESSI Board. They are past the much talked about planning stage and are only awaiting financing by their respective countries. The public authorities of the different countries have actually committed themselves to providing 25 percent of the total project cost with the EC also contributing 25 percent and the remainder being borne by the project participants.

**ELECTRONIQUE HEBDO:** Up to now, have the financial aspects been an obstacle?

**Paletto:** Everything which was stipulated in the Green Paper has been achieved. The first two years have been financially "covered" and a call for additional funding

will have to be made since certain projects have exceeded their estimates by 30 percent. However, the private sector appears to be much more committed than the public authorities. The latter should react just as quickly.

Another important, neither technical nor financial, result achieved during the first months of JESSI was the agreement on industrial property rights, which was reached at the end of April. It is indeed tempting to request competing companies to work together, but an agreement is still needed as to what each participant will get out of it once the joint research stage has ended. The defined rules were accepted by all of the participants, at all levels of cooperation and in the different sectors. They were also accepted by the EC with a view to establishing a more fruitful collaboration between the ESPRIT [European Strategic Program for Research and Development in Information Technologies] and JESSI programs.

**ELECTRONIQUE HEBDO:** Have the technological goals been reached?

**Paletto:** Three programs have been launched: the memory program, which was at the origin of JESSI; the submicron logical CMOS [complementary metal-oxide semiconductor] technology development program; and the computer-aided design (CAD) program. We already have prototype circuits in 0.7-micron CMOS technology and 16-Mbit erasable programmable read-only memories (EPROMs) in 0.5-micron technology are still expected by next year. According to Siemens, researchers are well ahead of schedule on the 16-Mbit dynamic random-access memory (DRAM) program.

**ELECTRONIQUE HEBDO:** What is going to happen to the static random-access memory (SRAM) program following Philips' withdrawal?

**Paletto:** The mere technological aspects should not present any problem, but this will not be the case at the level of mass production. However, the problem is a commercial rather than a technological one: The SRAM market is drying up and it may not really be necessary to hang on to it. Development of memory technology is continuing at SGS-Thomson for the EPROMs and at Siemens for the DRAMs. SGS-Thomson, the leading Western producer of SRAMs, feels capable of taking Philips' place in this sector. The only obstacle is the financing of the requisite investment.

**ELECTRONIQUE HEBDO:** Might not Matra MHS also be a candidate for developing advanced European SRAMs?

**Paletto:** Matra MHS is not really involved in the market of all-purpose SRAMs. The answer to the question of whether or not to replace Philips in the program is up to the JESSI participants. They have not yet decided.

**ELECTRONIQUE HEBDO:** Can you give us a breakdown of the 54 projects by subprograms?

**Paletto:** Of the 54 project proposals accepted by the JESSI Board, 45 percent fall under the materials and equipment subprogram and 43 percent under the applications subprogram. Philips, which continues to participate in the program for the development of high-density 0.5-micron application-specific integrated circuits (ASICs), is involved in more than 10 of the projects already accepted.

**ELECTRONIQUE HEBDO:** What is JESSI's position toward small European semiconductor manufacturers?

**Paletto:** Nine European semiconductor manufacturers are working together in the program dedicated to ASICs and digital technologies. This means that they are all involved, both large and small companies.

**ELECTRONIQUE HEBDO:** Why is there no specific microprocessor project in JESSI?

**Paletto:** The objective of JESSI is not to define an all-purpose architecture, but rather to contribute to the improvement of systems designed in Europe. To develop the best telecommunications systems, automobiles, and general consumer applications systems, one must have the best components, and therefore the resources to design and produce them.

**ELECTRONIQUE HEBDO:** What is JESSI's position toward the small and medium-sized enterprises (SME)?

**Paletto:** The SME-oriented JESSI project was one of the first accepted by the JESSI Board, together with the CAD project, which is no stranger in the SME area. Now, it remains to get the green light from the various countries involved. In Germany, this is done; in the Netherlands, the green light was to be given at the time when Philips announced its withdrawal from SRAM, which slowed down the process; France is dragging its feet a bit; and in Italy, it is quite difficult to know what is going on.

**ELECTRONIQUE HEBDO:** What is your relationship with Sematech?

**Paletto:** We have agreed to define new possibilities for cooperation, which should be mutually beneficial to each party. At the outset, our agreement covered standards and the development of a joint analysis of competition. However, it should be born in mind that since the two projects are essentially completely different, the possibilities of cooperation are relatively restricted. Sematech focuses on the development of a production plant, including its physical establishment. This is not the case with JESSI, whose main goal is to enable participants with more or less the same know-how to share technological development costs, while giving them complete freedom in the design and manufacturing of new products. In the third stage, collaboration between European and American companies could be possible, particularly in the area of production equipment. Europe has already taken the first step: IBM is participating in two projects of JESSI's equipment and materials subprogram. This

proves that JESSI is not an impregnable fortress. The ball is now in Sematech's court.

**ELECTRONIQUE HEBDO:** What is JESSI's position with respect to Japanese companies which carry out R&D in Europe?

**Paletto:** If they have R&D and manufacturing facilities in Europe, why not open the doors of cooperation to them, on terms of reciprocity, obviously. However, that is not really in the cards. If Europeans really want to hold out, it is in their interest to have high-quality and very advanced products at their disposal. The problem is to have such products. JESSI's aim is to provide them to European industry, that is to say, it will supply the technology and equipment needed for their production.

### **JESSI, SEMATECH Define Collaboration**

91WS0042C Paris *ELECTRONIQUE ACTUALITES*  
in French 12 Oct 90 p 20

[Text] Jessi and Sematech exchanged information from research conducted in projects established in March of 1990. Information on the project dubbed "Comparative Analysis of Techniques" was presented: "Comparative analysis of techniques" covers investigations of technologies. The second project, on standards, has entered the executive phase.

Work on standards is intended to facilitate substitution of hardware among users.

Moreover, cooperation between the two programs has been stepped up, now that common areas of activity have been identified. Current equipment and hardware needs have been inventoried to help Western companies become more competitive. Additional working groups have also been set up.

Jessi's activities will be presented during Electronica, on the morning of 6 November. The heads of the program and of different Jessi sub-programs (technology, equipment and hardware, applications) will present their work and field questions from participants.

### **ESPRIT Chairman on Electronics Industry**

91AN0075 Rijswijk *POLYTECHNISCH WEEKBLAD*  
in Dutch 18 Oct 90 p 9

[Article: "Information Technology Heading for Hard Times"]

[Text] Nineteen eighty-nine was a successful year for ESPRIT, the European Strategic Program for Research and Development in Information Technologies, according to Chairman J.M. Cadiou. He believes that Europe has considerably strengthened its position. He believes that Europe has considerably strengthened its position. Nevertheless, he expects hard times in the next five years due to growing competition from other parts of the world.

To cope with this threat, Cadiou says that companies will have to invest heavily in research and development and that technologies need to be integrated more rapidly into commercial products. This is the only way for Europe to maintain and improve its position.

The European information technology market grew rapidly in 1989 with an increase of approximately 16 percent, bringing it to a total of \$133 billion. According to Cadiou, this market grew quicker in Europe than in other parts of the world.

The ESPRIT program, which began in 1984, now consists of 384 projects in progress, including 137 under ESPRIT II. Cadiou says that last year a number of important projects were added in the field of very-large-scale integration (VLSI) design and parallel computer technologies. The annual report indicates that, so far, 152 ESPRIT projects have resulted in new products or services within the participant's own organization. The new technologies and methods developed under 118 other projects were used elsewhere. Another 43 projects have contributed to the development of international standards.

By the end of 1989, 971 companies or organizations were involved in ESPRIT. Cadiou is particularly pleased with the sharply increasing participation of European small and medium-sized companies. In 1988, 146 of them were involved in ESPRIT; last year, this number went up to 386. The remaining participants include 292 large companies, 184 universities, and 109 research institutes.

### **France: Advanced Printed Circuit Technologies Described**

91WS0056D Paris *L'USINE NOUVELLE/*  
*TECHNOLOGIES* in French 18 Oct 90 pp 56-62

[Article by Thierry Lucas: "New Challenges for Printed Circuits"]

[Text] **Thinner tracks, smaller holes, more and more layers: Printed circuits get a new look. And new substrates make them suitable for use at high temperatures and hyperfrequencies.**

Sent to the bottom of oil drillings, shipped on board aircraft and submarines, compelled to keep with advances in microelectronics, printed circuits hold out and innovate. They may get less attention from the media than integrated circuits, although they are the latter's indispensable interconnection carriers, but they are just as innovative: ultra-thin conductor tracks (100 microns), multiple layers stacked and interconnected through minuscule plated-through holes (0.2 mm), special high-temperature or high-frequency materials, flexible circuits.... They will use everything to meet users' increasingly sophisticated requirements.

One of the leading users is the computer industry: Increasingly powerful computers call for minor miracles

when it comes to density. What do computer manufacturers actually want? Hardware that will perform complex functions and take as little space as possible. As far as components are concerned, integrated circuits have put entire computers onto small chips. Printed circuits, for their part, have done their best to follow suit: The system board of a Bull DPS-7000 computer is built on a 12-layer circuit, with conductor tracks 100 micron wide, and interconnection holes only 0.3 mm in diameter (0.2 mm for internal layers). This "high-end" product is manufactured at the Bull plant in Angers, which produces 200,000 m<sup>2</sup> of multilayer printed circuits every year.

Microcomputers are hardly less demanding. For SMT-Goupil, the Alcatel-CIT plant in Coutances (Manche) produces microcomputer system boards consisting solely of surface mounted devices (SMD's) with 140-micron tracks and 0.3-mm holes. This unit of the Alcatel group (62,000 m<sup>2</sup> of dual-sided and multilayer circuits) works 75 percent for the telecommunications market, but also for the computer market, as we just saw, and for the measurement and automotive sectors. The telecommunications sector accounts for one third of the output of Philips Components in Evreux, the "top level" of which consists of circuits with line widths of 125-150 microns, holes 0.3-0.4 mm in diameter, and up to 12-14 layers. As a comparison, automotive electronics today requires only 200 microns, 0.6 mm and 4 layers.

To increase circuit density, designers have a choice of two strategies: multiply the number of layers or reduce the size of tracks and holes in each layer. To produce a multilayer circuit, copper plates alternating with pieces of prepregged cloth (e.g., glass fiber/epoxy resin) are stacked. The art of doing it involves hot pressing these heterogeneous materials, which have different physical characteristics, without disturbing the perfect alignment of the etched patterns and interconnection holes.

"Some computer manufacturers, like Fujitsu, have pushed that trend to the limit, making circuits of up to 42 layers!" Jany-Yves Haslouin, head of the printed-circuit technical department at Bull Angers, pointed out. Other users have also chosen multiple stacks, and all manufacturers can boast records: 16 layers for a product used on a submarine, made by Cimulec, a small to medium-size company created by a former employee of Serge Dassault Electronics and specialized in multilayer and specialty circuits. Ciretec, a subsidiary of the Cire group—which includes several small to medium-size companies working in this field—has made a 20-layer circuit for the European Nuclear Research Center (CERN). As a rule, these boards contain "buried holes" which connect internal conductor plates together and increase the interconnection density. These results show what can be produced today in small or mid-size series, but they should not conceal the drawbacks of this approach: High cost and difficult implementation, even though the number of stacked layers does not necessarily reflect the difficulty encountered in manufacturing the circuit.

### High-Density Circuits: Industrialization Problems

Most experts also strive to increase layer density. These developments are accompanied by considerable industrialization efforts. Actually, although anybody can produce a high-end prototype, manufacturing it in series with an acceptable output rate is another story. "We are interested in large volumes," Michel Jouan, in charge of sales at the integrated-circuit division of Alcatel-CIT, explained. "Within two years, we will produce line widths of 100-120 microns in large series, with an acceptable output rate; that will enable us to increase density while keeping the number of layers rather low." Simultaneously with this development, the Coutances plant is being extended and its capacity should double by 1992.

At Bull, people are working on what they call Class 6, a project scheduled to be completed within the next two years: 75-micron tracks, 100-micron insulation widths, buried holes 0.15 mm in diameter. "To advance, we must work on image and etching transfer techniques and set up the corresponding clean (Class 100) rooms," Jany-Yves Haslouin pointed out. To achieve 0.15 mm holes, they use a new drilling machine working at 100,000 rpm and provided with a broken-bit detection system based on the automatic analysis of ultrasonic response curves.

On the subject of drilling, it seems that the use of laser, which was considered for a time, did not yield convincing results. Given a stack of very heterogeneous materials, the holes made by a laser beam will have a very irregular profile and cannot be plated through. This is probably where the true difficulty lies. There is no point in multiplying layers or drilling minuscule openings if you cannot plate them properly to make them act as conductors. "During chemical, then electrolytic copper-plating, the only problem is to ensure proper circulation of the liquids through the holes," Jean-Pierre Le Pendeven, in charge of international marketing at the integrated-circuit division of Philips Components, explained. "Therefore, because of capillarity phenomena, the parameter that really has to be optimized is the relation between substrate thickness and hole diameter." It is therefore the manufacturer's knowhow that makes the difference. A set of tricks, kept more or less secret, like using mechanical impacts or ultrasounds to dislodge trapped bubbles, but also specific production equipment testifying to the difficulty encountered in mastering these processes at industrial level. Bull has chemical and electrolytic copper-plating shops that are reserved for high-density circuits. These production lines are provided with computerized process-control systems that include predictive maintenance. In addition, the electrolytic copper-plating vats are small, which makes it easier to adjust current density (and therefore the thickness of the deposited copper layer).

The race for density is far from over; still at Bull, people consider that "it should be possible to achieve etching lines as fine as 50 microns, if we keep pushing the limits



of present well-known manufacturing techniques." This trend calls for a more general use of CAD/CAM [computer-aided design and manufacturing]; the numeric data it provides could be used for drilling-machine control, film deposition, and automatic circuit testing and optical control. Pending direct image transfer by laser, without intermediate photograph.

At the same time, printed circuits must demonstrate their adaptability in another respect. Actually, although most of them still use a substrate of glass-fiber impregnated with epoxy resin (the material known as FR4), this material has shown its limitations in some applications. Thus, the substrate must sometimes possess an excellent resistance to high temperatures: for instance when wave soldering SMD's, or for electronic boards destined to operate in a "high-temperature" environment.

#### **Polyimide Substrates for High-Temperature Applications**

With a glass-transition temperature (250°C) 100°C higher than that of epoxy, and with the advantage of a low expansion coefficient, the polyimide resin is far better suited to such conditions. Therefore, glass-polyimide substrates will be used for "high-temperature" applications such as oil drilling: at the bottom of oil drillings, the equipment must withstand temperatures on the order of 150°C....

In spite of its price—four to seven times as much as FR4—the glass-polyimide substrate has conquered the particularly demanding markets of military and civilian airborne electronics. It is still rarely used in computers, where temperature can be regulated. However, Bull has manufactured a "high-temperature" circuit....for an outside client's computer application. "Polyimide does not have only advantages," Jany-Yves Haslouin pointed out. "Its mechanical characteristics lead to cleavage problems, so that the circuit must be milled instead of sheared. In addition, there is a moisture-absorption phenomena so that precautions are required when installing components."

Components are also another source of heat on the electronic board: The heat produced during operation has to be evacuated. Moreover, the expansion caused by the heat thus produced is not the same in all the materials in presence, and this can lead to deterioration. "The expansion coefficient of the substrate must be brought down to a value compatible with that of the SMD ceramic packages," Jean-Pierre Lucas, Cimulec president and founder, indicated. "We can do this by inserting in the multilayer circuit one or several plates made of copper-Invar [64-percent iron, 36-percent copper alloy]-copper or copper-molybdenum-copper." Another technique, developed by Cimulec jointly with the Metz University, uses a layer of memory-shape alloy. Laboratory tests were qualified by a client of Cimulec, Simsa-Sintra, but alloy sheets in sufficient quantities must be available before the process can be industrialized.... As for heat evacuation, it can be achieved either

through a Cu-Mo-Cu core (which would thus fulfill a dual function) or through an external drain: a sheet of metal stuck on the circuit facilitates heat dissipation.

Another challenge for board designers: the emergence of very-high-speed integrated circuits and the need for substrates with a dielectric constant as low as possible. This concerns the hyperfrequency range (radars, antennas) as well as computers, since their processors are clocked at ever increasing frequencies. Teflon substrates provide a good answer to these problems, if you don't mind the cost: a teflon substrate costs at least 10 times as much as FR4! As a rule, these are dual-sided circuits with plated-through holes which are sometimes enclosed between two shield plates. Most subcontractors working on high-end products have had to tackle this technology, which has its difficulties: It requires a special plating process, and the layout of controlled-impedance conductor lines calls for an excellent etching precision. "The tolerance requirement is 15-20 microns, whereas 50 microns are considered adequate for other applications," we were told by Rene Balmet, sales manager at Nicolitch, a 450-employee company specialized in professional printed circuits. "In addition, a mechanical precision of 5/100 is required to insert the circuit in a molded package.

#### **Low Dielectric Constant Substrates for High-Frequency Applications**

To meet the needs of the high-frequency market at a reasonable cost, manufacturers like Ciretec make controlled-impedance conductor lines on a less costly substrate: The so-called "high-temperature" FR4 which, in addition to improved heat resistance, offers the advantage of having a lower dielectric constant. "To prevent impedance fluctuations, we must first make sure that the layers remain parallel while they are being pressed," Jean-Louis Calvet, Ciretec manager, explained. "This can be done by pressing under vacuum, a method that reduces stress and limits dimensional variations. The other important point is to control track width at the time of etching." The Cire group subsidiary has thus made large (17,000 holes!) impedance-controlled 8-layer circuits for testers developed by IBM France for its own use.

Computer manufacturers are also gearing up for the high-frequency era. The Bull engineering department has made prototypes out of teflon and cyanate ester, another resin with a low dielectric constant, in order to test the performance of both materials and to study to what extent they could be used on an industrial scale.

In their efforts to innovate, however, circuit manufacturers are not considering only the products; the evolution of processes, too, could well bring some drastic changes in the printed-circuit industry. Producers are focusing in particular on two trends: cost reduction and pollution limitation.

As far as consumer products are concerned, the "dual-sided silver-plated holes" technology has brought about

a small revolution. This process is replacing chemical and electrolytic copper deposition (used to make the holes that connect the two sides act as conductors) with silk-screening using a silver-containing paste. "The result is a circuit which performs nearly as well as a traditional dual-sided circuit, for a price that is only 1.5 times that of a single-sided circuit, compared with a ratio of 2.5 with the 'copper' process," Pascal Poisson, manager of BREE, another subsidiary of the Cire group specialized in consumer electronics (telephone, TV, hi-fi), explained. Three years ago, the company pioneered the use of "silver paste" in France. Today, 50 percent of its production (which used to be 100 percent single-sided non-plated circuits) is based on the new process. Thus, Philips Components in Evreux has acquired a large production line for this process, in anticipation of a strong demand for large series.

Always eager to find economic solutions, BREE also started producing dual-sided products with "carbon paste" connection holes. The principle is the same as with silver paste (silk-screening), but carbon paste is three times less expensive. Unfortunately, the high resistivity of carbon limits its use to a few applications, essentially keyboards for pocket calculators and push-button telephone dials.

For multilayer circuits, a similar approach seems promising: The Blackhole process of Olin Hunt is gaining ground. Already well introduced in the United States, this technique replaces chemical copper-plating with the deposition of a very thin carbon conductor coating. "This carbon 'plating' offers many advantages," we were told by Jean-Louis Calvet of Ciretec, who has been experimenting with the Blackhole process for a few months. The absence of metal reduces pollution, and therefore the cost of treating effluents. Fewer deposition and rinsing stages are required: Three baths are enough. And that is irrespective of the circuit substrate material. Hence a productivity gain. Finally, there is no chemical reaction, and therefore no bubbles, so that liquid circulation through the holes is improved. "All these advantages did not escape the attention of Nicolitch and it has set up a complete Blackhole line in its plant, for evaluation.

#### Testing High-Density Circuits: A Tough Problem

To remain in phase with their clients, printed-circuit manufacturers are working in many directions. One of these, however, seems to pose rather difficult problems: How can manufacturers test increasingly complex circuits? In other words, how can they check that the product complies with its specifications and prove its reliability? Such demands on the part of clients are easy to understand, but they involve an additional cost which they may find hard to accept. "There is no ideal solution," Rene Balmet of Nicolitch, complained. "In a buried-hole multilayer circuit, the only way you can check the continuity of internal connections is to perform an electric test simultaneously on both sides. A tester like that represents a large investment (several

million francs), which is not warranted for smaller series. Moreover, the test itself is expensive and may account for a large portion of the board cost." A technical-economic tradeoff must, therefore, be achieved, in agreement with the client. For many manufacturers, the combination of automatic optical inspection with a traditional electric test appears to provide the best industrial solution. Optical inspection checks that the circuit layout is correct, without being limited by circuit density, and makes it possible to distinguish between actual and false defects. The electric continuity and insulation test complements the result. The use of digitized CAD/CAM data should also provide significant help in selecting the obligatory test points. As for the quality of internal connections...it tends to be related to the overall quality-control policy implemented during the entire manufacturing process.

[Box, p 58]

#### A Range of Substrates

A priori, the printed-circuit designer can choose among the many available substrates the one best suited for his application. But in fact his choice is somewhat limited by the cost and difficulties of implementation of some materials. If we leave aside the substrates made of paper impregnated with phenolic or epoxy resin (FR2 and FR3), which are used for consumer products, the glass-epoxy preimpregnated substrate (FR4) dominates by far the professional market.

Fully mastered by manufacturers, who have explored all its characteristics, and with a reasonable cost, the FR4 substrate is in fact well-suited for the many applications which do not require exceptional performance characteristics. Its glass-transition temperature ( $T_g$ ), i.e. the limit not to exceed during circuit manufacturing or utilization, is 125°C. A "high-temperature" FR4 is also available (at a much higher price); it has a  $T_g$  of (about) 180°C.

Above that temperature, for instance to withstand wave soldering of components (at temperatures over 200°C), the glass-polyimide substrate is a must. The  $T_g$  of polyimide, for instance the Rhone-Poulenc Kerimid resin, is about 250°C.

There are also quartz-polyimide laminates, and kevlar-polyimide substrates which offer the advantage of dimensional stability. Polyimide films, for instance the Du Pont Capton, are also used in flexible and flex-rigid circuits. For hyperfrequency applications (antennas), the dielectric constant of the material must be as low as possible. The best candidate today is teflon. "A necessary evil," considering its price, and one that requires a special production line. Another resin, cyanate ester, allies a low dielectric constant with a fairly high  $T_g$ . But its price remains prohibitive.

[Box, p 61]

### Flexibility, an Additional Asset

To adapt to the environment, nothing beats flexibility. Flexible circuits and flex-rigid circuits (in which a flexible part connects the rigid boards) were developed with two objectives in view: reduced overall dimensions, imposed by some applications; easy and reliable connections between circuits. Ciretec, for instance, has put four circuits and their wiring on a single flex-rigid circuit: The "hard" parts (with a glass-polyimide substrate) are interconnected by flexible parts made of Kapton (another polyimide). The assembly is used on a submarine. The subsidiary of the Cire group has also supplied a famous manufacturer of red cars with a flex-rigid electronic ignition circuit for formula-one cars: eight layers in the rigid part made of FR4, and 6 flexible layers. Avionics is another large consumer of flex-rigid circuits. At Nicolitch, several products use flexible substrates. In addition to the traditional flex-rigid circuits, the group offers a line (the Sterflex line) of flexible interconnection circuits made of polyimide and whose rigid terminals are integral extensions of the conductors. By varying the copper thickness, this technology of American origin makes it possible to adjust rigidity and flexibility at will. As a result, the circuit and terminals can be shaped, and connectors eliminated.

Flextherm, a flexible heating circuit, was developed by Nicolitch jointly with the CNES [National Center for Space Studies]. Resistors are etched into the metal, which is placed between two insulating Kapton sheets. This heater may be given any shape and is used to regulate the temperature of on-board equipment (optics, electronics, etc.) especially in the aeronautical and space sectors.

[Box, p 62]

### 3D Circuits: Limited Use

Available for several years already, 3D circuits are still not widely used. Yet, this technique, which makes it possible to obtain directly complex-shape circuits molded out of a high-end plastic (PES [polyether sulfon], LCP, PEEK [polyether ether ketone], etc.) has led to developments at several large plastics manufacturers: Du Pont, GE Plastics, ICI [Imperial Chemical Industries], BASF [Baden Anilin and Soda Factory] offer plastics suitable for this method, often bundled with a special molding technique. But for integrated-circuit specialists, this means a complete overhaul of all production processes, and the cost of the mold makes it imperative to produce large series. After that, there is the problem of mounting components on a 3D substrate....

### Germany: Dresden ASIC Center Develops Digital Signal Processor

91WS0049 Berlin RADIO FERNSEHEN  
ELEKTRONIK in German Oct 90 pp 680-682

[Article by Dr.-Ing. Wolfgang Klein, Dipl.-Ing. Gerhard Teucher]

[Text] The U 320 C20 FC digital signal processor was developed in the Dresden ASIC Center, a part of the former Microelectronic Research Center. Initial samples are already undergoing user testing. Series production is to start by the end of 1990. This article introduces this interesting component.

### What Is a Digital Signal Processor (DSP)?

The world is analog. All changes to physical quantities in our environment appear as analog (continuous) in-time signals. The signals are converted into "digital" signals in appropriate converters by discrete-in-time sampling and quantizing the signal value. Further processing of these signals using digital computers is known as digital signal processing.

The digital implementation of signal-processing systems provides a number of advantages over the analog solutions. In particular, these are the excellent reproducibility, long-term invariance, and a good ability to integrate the solution in silicon. For example, in digital filters (one of the main applications of DSPs), any transmission curve (even of higher orders) can be set using software to be exact and stable. The filter can be designed so that it can be tuned, and the attenuation can be programmed to the ideal value of 1.

The principle of the digital processing of analog signals has been known and scientifically analyzed for a long time. The conditioning of the signal entails first decomposing it into series. The nucleus of these series is often a scalar product of two vectors. For this reason, it is important to perform multiplications and additions at high speed.

Digital signal processors are circuits that can be numbered among the highly integrated microprocessors in terms of their technology, their degree of integration, and many internal structural elements (e.g., program counter, stack, ALU).

In contrast to "standard" microprocessors, they have special structures for rapidly handling arithmetic, signal-processing-type operations in only one clock cycle. The presence of a multiplier followed by an accumulator (MAC) as a typical DSP structure has to be specially emphasized. With such structures, they allow a considerably higher processing speed for such operations in comparison to a universal microprocessor. Added to this are the capability of being connected in a multi-processor topology and the integrated serial port. In several application areas previously reserved for analog

technology, digital signal processors have become indispensable, e.g., speech processing, image processing, control technology. The many potential applications of digital signal processing are shown in Figure 1. The median and mean filters serve as examples from image processing. They handle complete image data (100,000 up to a few million pixels with 100 to 1000 shades of gray or color) such that each pixel, instead of its original data, contains the median or mean of the surrounding window (e.g., 5 x 5 pixels). This creates some desired optical effect.

Digital signal processors make it possible for the first time to use effectively the mathematical methods of digital signal processing. These methods, e.g., Fourier transformation, have been known for a long time. The processing is done in a decentralized fashion under real-time conditions. The equipment used does not exhibit any disadvantages with regard to size or energy consumption over comparable, analog equipment but does provide the advantages of considerably higher precision and variability. Market analyses clearly show that DSP is becoming one of the basic components of advanced microelectronics. This is comparable to what happened 30 years ago for the transistor, 20 years ago for the operational amplifier or 15 years ago for the microprocessor. The U 320 C20 FC digital signal processor introduced in this article is functionally compatible with the TMS 32020. This component is already being used worldwide and comes from Texas Instruments, the world leader in DSP.

The U 320 C20 FC DSP is a 16-bit CMOS microprocessor for digital signal processing and universal application. Its internal memory (for data and the program) provides the circuit with characteristics similar to those of a signal-chip microcomputer. The four basic mathematical operations are implemented in hardware (addition, subtraction and multiplication each execute in one instruction cycle, division is a function of the number of digits). The most important properties of the U 320 C20 FC are summarized in the Table. Figure 2 shows the pin designation. Properties of the U 320 C20 FC digital signal processor

- 200 ns instruction cycle
- multiplication and accumulation in one cycle
- 544 words (16-bit) of internal RAM

- can execute instructions from internal RAM (256 words can be configured as program memory)
- 128K words (16-bit) total address space, subdivided into 64K each for data and programs
- external bus system: 16-bit data bus, 16-bit address bus
- 16 input and 16 output ports
- 16-bit instruction and data words
- 32-bit ALU and 32-bit accumulator
- parallel hardware shifter for shifts by 0 to 16 bits (32-bit output)
- hardware multiplier for 16-bit operands produces a 32-bit result with the correct sign in one instruction cycle
- 5 auxiliary registers and the corresponding second ALU for indirect addressing and address modification
- 16-bit timer
- integer and fixed-point operation with arbitrary positioning of the decimal point
- instructions for supporting floating-point operations
- block moves in data and program memory
- instruction repetition (max 256 times)
- bit manipulation and boolean instructions
- address modes: direct, indirect, indexed (increment, decrement, addition, subtraction), immediate operand
- 109 instructions
- serial port (e.g., for indirect codec interface)
- 3 external, maskable interrupts
- synchronization input and global memory control output, particularly for multiprocessor systems
- 20 MHz quartz oscillator for  $5 \times 10^6$  instructions/s
- TTL-compatible inputs and outputs
- CMOS circuit technology
- 5V operating voltage
- power consumption: about 0.5 W at 20 MHz
- 68-pin housing (QFP 68)

#### Architecture

The proposed symbol for the DSP is shown in Figure 3. The U 320 C20 FC uses the modified Harvard architecture. The essential features of this architecture are separate buses for instruction execution and data transfer. Accordingly, the address spaces for the program and data are also logically separate. In addition, each of the two buses has its own address bus. These four buses provides extensive parallelism of the internal operations thereby achieving a high processing speed.



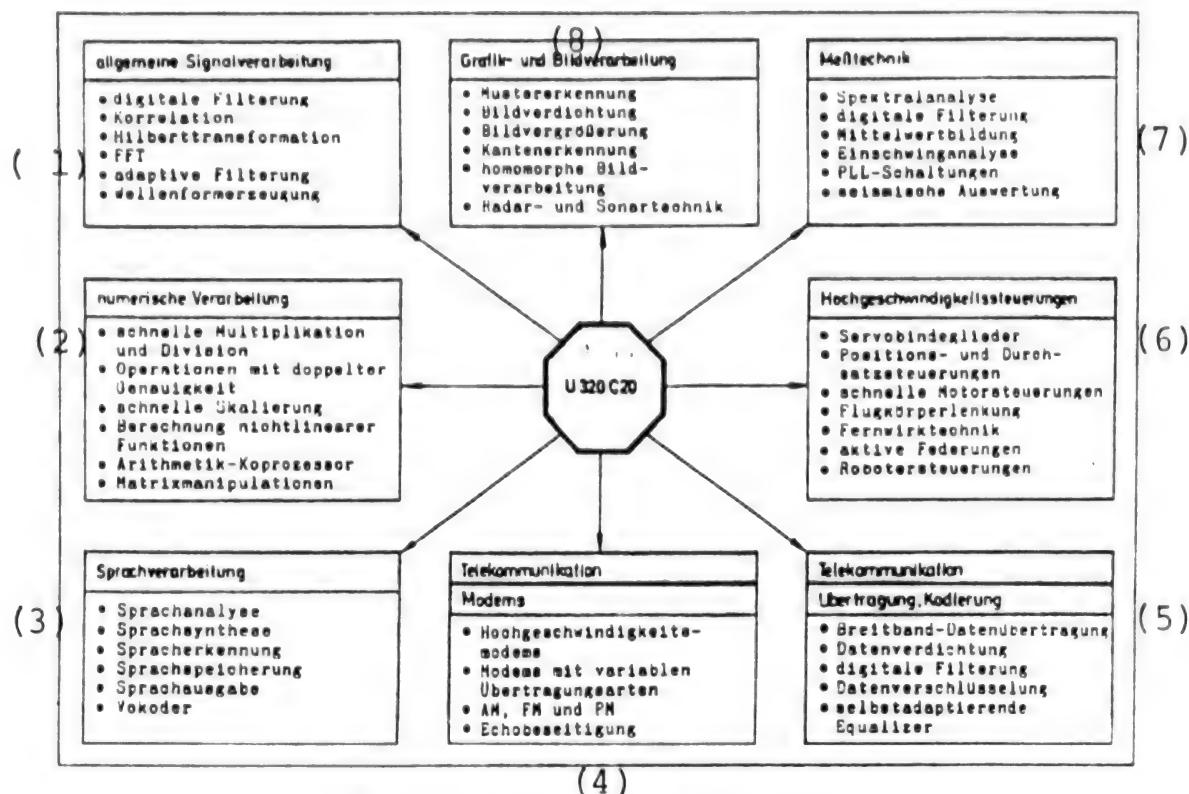


Figure 1: Applications of digital signal processing

Key: (1) General signal processing

- digital filtering
- correlation
- Hilbert transforms
- FFT
- adaptive filtering
- signal generation

(2) Numerical processing

- fast multiplication and division
- operations with double precision
- fast scaling
- computation of nonlinear functions
- arithmetic coprocessor
- matrix manipulations

(3) Speech processing

- speech analysis
- speech synthesis
- speech recognition
- speech storage
- speech output
- vocoder

(4) Telecommunications: modems

- high-speed modems
- modems with variable transmission modes
- AM, FM and PM
- echo elimination

(5) Telecommunications: transmission, coding

- wide-band data transmission
- data compression
- digital filtering
- data encoding
- self-adaptive equalizer

(6) High-speed controls

- servo connectors
- position and throughput controls
- high-speed motor controls
- missile control
- remote technology
- active suspension
- robot controls

(7) Measurement technology

- spectral analysis
- digital filtering
- mean-value generation
- transient analysis
- PLL circuits
- seismic evaluation

(8) Graphics and image processing

- pattern recognition
- image compression
- image expansion
- edge recognition
- homomorphic image processing
- radar and sonar technology

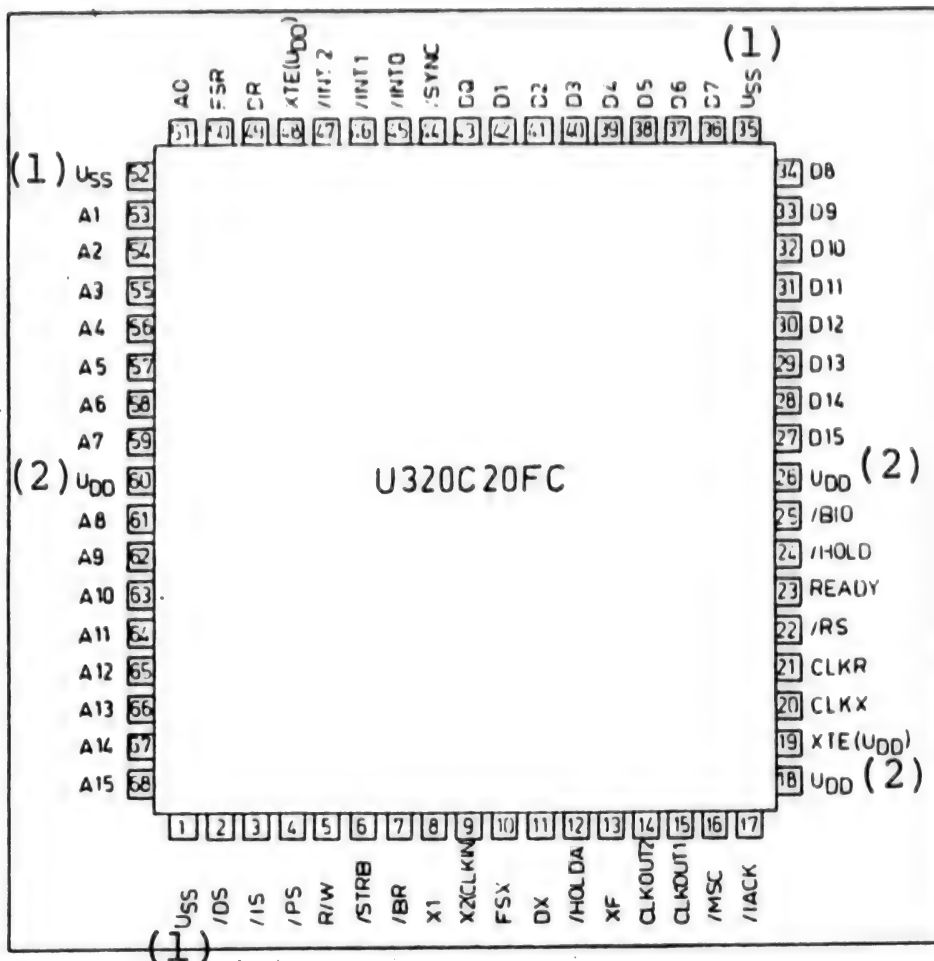


Figure 2: Pin designations

Key: (1)  $V_{ss}$  (2)  $V_{dd}$ 

### Central Processing Unit

The following functional units are part of the central processing unit:

- 32-bit arithmetic logic unit for addition, subtraction, boolean AND, OR, XOR (ALU)
- 32-bit accumulator (ACC)
- multiplier field (16 x 16 bit) with P and T registers
- shifter 0 to 16 (barrel shifter, before the ALU)
- shifter, -6, 0, 1, 4 (following the P register)
- shifter 0, 1, 4 (following the ACC, subdivided into the H and L portions at the output).

### Memory Configuration

The available memory areas are logically separated into program memory and data memory, each with 64K words. A physical separation exists between the internal and external memory areas. The upper 256 words of the

program memory (starting at address 65280) may be occupied by the internal memory block B0 (depending on the status bit CNF). All other program-memory addresses are connected with an external access. The data memory comprises an internal area of 288 words that can be increased to a total of 544 words by the internal memory block B0 (depending on the status bit CNF). All internal data memory areas lie within the data memory addresses 0 to 1023. External accesses occur starting at address 1024.

### Registers

#### Auxiliary Registers

The five 16-bit registers AR0 to AR4 contain data addresses used for indirect addressing. These registers are assigned their own 16-bit arithmetic unit. The contents of the auxiliary registers can be modified using this register ALU (RAU).

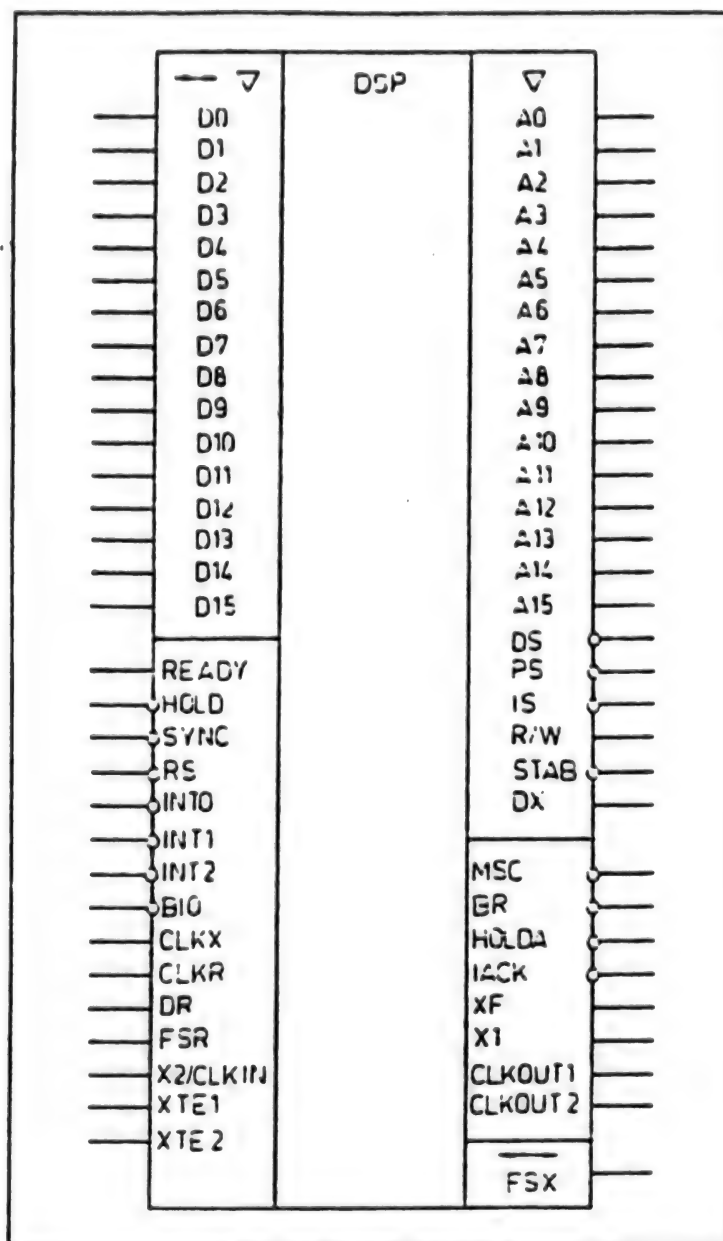


Figure 3: Proposed symbol

#### Status Registers

The two registers ST0 and ST1 are 15 bits and 11 bits, respectively. They contain 11 flags used to control the most varied functions in the processor.

#### Arithmetic Registers

The accumulator (32-bit), the T register (16-bit) and the P register (32-bit) are the arithmetic registers. The accumulator is used for temporary storage of an operand or the

result of boolean and arithmetic instructions. The T register contains an operand during multiplication instructions while the P register stores the product.

#### Program-Control Registers

There is one 16-bit program counter (PC) and one stack (4 levels, 16 bits each) the 8-bit repeat counter (RPTC) is used to repeat an instruction (up to 256 executions of the same instruction).

### Memory-Resident Registers

The six memory-resident registers can be used just like data memory locations. However they also have additional special functions. They occupy the addresses 0 to 5 of the data memory and may be read from or written to at any time.

DRR = data received register (serial port)  
 DXR = data transmit register (serial port)  
 TIM = timer register (timer)  
 PRD = period register (timer)  
 IMR = interrupt mask register  
 GREG = global memory area register

### Buses

The external buses are the external data bus (data pins D0 to D15) for data and instructions, and the external address bus (address pins A0 to A15) for addressing the external data and program memory. Besides these, the following internal 16-bit buses are available:

- data bus (DB) (transports the data between all major functional blocks on the chip)
- program bus (PB) (transports the currently read instruction from the internal RAM block B0 or from the data pins to the instruction registers)
- bus coupler (allows transmission of a 16-bit word (e.g., an immediate operand, a jump address) from the program bus to the data bus)
- data address bus (DAB)
- program address bus (PAB).

### Instruction Groups

- Accumulator-memory instructions: arithmetic boolean, shift and transport operations
- Memory operations: operations in the data or program memory that do not affect the accumulator (e.g., block move and table instructions)
- Auxiliary register operations: these are used for indirect addressing and address calculation
- Multiplication instructions: these also include instruction for combined multiplication and accumulation, for squaring and instructions for loading the T register and further processing of the contents of the P register
- Jump instructions
- Control instruction: using the flags in the status registers, these instructions control program sequence or special operations (e.g., bit testing, waiting for an interrupt, instruction repetition, a software interrupt)
- Input and output operations.

### Addressing Modes

Data memory addresses are generated using direct or indirect addressing. Both addressing modes can be used as

desired for instructions with data memory access. In addition, it is possible to use immediate operands in the instruction and to specify the complete 16-bit address (start of the block) in the instruction for block move instructions. Address modification is possible during indirect addressing. In this way, the contents of the current auxiliary register (address register) can be changed: incrementing, decrementing, addition, subtraction.

### Further References

The U 320 C20 FC Manual with a detailed functional description, descriptions of the instruction set, the hardware and software for supporting program development and application notes will appear in autumn 1990 in the Verlag Technik.

### Germany: Fraunhofer Silicon Technology Institute Established

91MI0073 Duesseldorf *HANDELSBLATT in German* 20 Nov 90 p 23

[Text] Itzehoe, 19 November (Handelsblatt)—At a groundbreaking ceremony in Itzehoe, Schleswig-Holstein's Prime Minister Bjoern Engholm gave the signal to start construction of the Institute of Silicon Technology (ISiT), which is due to begin operation in 1994 as part of the Joint European Submicron Silicon (JESSI) project.

ISiT will investigate the development potential of silicon-based microelectronics. This potential goes beyond the 256-megabit chip and reaches into the giga range (mega = millions, giga = billions). At ISiT, cost effective applications of X-ray lithography will be investigated as an important contribution to processing and manufacturing technology, as it is impossible to make increasingly tiny microstructures with light optic processes. For this purpose, a compact storage ring will be installed in Itzehoe as an X-ray light source and funded by the federal Research Ministry with an additional 10 to 15 million German marks [DM]. This X-ray light source was chosen in consideration of the development work currently underway at IBM's Fishkill research institute, in which Siemens AG is also taking part.

An ambitious short-term goal is to produce a 64-megabit memory chip. ISiT will not develop the 16-megabit chip as IBM and Japan have already done so, albeit only as an incomplete laboratory sample.

Financing for the DM400 million project, which is managed by the Fraunhofer Institute, is being provided equally by the German Government and the Land. When completed, the institute will employ 400 people. The Land of Schleswig-Holstein and the surrounding region consider the ISiT settlement to be extremely important from a structural policy viewpoint, as the research results developed in Itzehoe will work to the advantage of local medium-sized enterprises in the medium and long term.

### Netherlands: JESSI Funding Problematic

91AN0108 Rijswijk *POLYTECHNISC WEEKBLAD in Dutch* 15 Nov 90 p 3

[Article by Eduard Voorn: "Withholding of Government Subsidies Delays Dutch Participation in JESSI"]



[Text] The funding of the Joint European Submicron Silicon Initiative (JESSI), the European chip project, continues to cause problems. The withholding of [government] subsidies have caused Dutch companies to now incur delays of up to six months.

Officials from the Ministry of Economic Affairs have kept the Dutch JESSI participants waiting for more than a year now. "We do have oral commitments, but we have not yet received any letter of intent, let alone any money," explains prof E.J.R. Kamerbeek from ASM. "This delay slows down the start-up phase. Philips' withdrawal from the static random-access memory (SRAM) project has even further slowed down the assessment procedure at the Ministry of Economic Affairs."

For the Dutch small and medium-sized companies, the threshold remains as high as ever before. Those who do submit an application usually see it rejected because it does not meet the stringent requirements.

The Foundation for Microelectronics Centers (SCME) is running a special program to stimulate the interest of Dutch small and medium-sized companies in JESSI. Here, too, the major problem is the total lack of support by the Dutch government. But there is still hope: High-ranking officials of the Ministry of Economic Affairs have promised funding will start as of the beginning of 1991.

#### Research

The same goes for R&D. For instance, Dutch universities and institutes would like to conduct research into 0.25-micron line widths in CMOS technology or produce complex circuits containing 100 million transistors, but they cannot start for lack of money. The problem is that the Ministry of Education and Sciences, which is supposed to finance this project, has not budgeted for it. A working group with officials from the Ministries of Economic Affairs and Education and Sciences are presently working on a solution to overcome this problem. "Personally, I am very pessimistic, but I have faith in man's good nature," says a spokesman of the Institute for Basic Research into Matter (FOM)/STW. This organization promotes the interests of Dutch universities and institutes. "For the duration of the project, which is eight years, a budget of 96 million guilders has been proposed. On an annual basis, this is acceptable. It is strange that both the government and Parliament acknowledge the importance of microelectronics, but fail to act accordingly."

The surrounding countries have already appropriated or promised certain amounts. France has been financing research and development since April. The German Government last week allocated 200 million German marks in order to finance the Institute for Silicon Technology at Itzehoe, where research will be conducted into manufacturing technologies within the framework of JESSI.

JESSI chairman Dr R. Paletto, who is also R&D manager with SGS-Thomson, blames the Dutch authorities for the funding problem. "Within JESSI, the participation of small and medium-sized companies is satisfactory, except for the Netherlands. The same is true for basic and long-term research. I tried to make an appointment with the Dutch Minister of Economic Affairs, but I was told he was too busy. This is a problem of the Netherlands."

A spokesman from Economic Affairs expects that a decision about the 1990-1991 period will be made before long.

#### Money

According to Paletto, the interest in JESSI is so overwhelming that the budget will be far inadequate. In spite of his smooth public relations talk about the project, it is obvious that funding is its Achilles heel. In addition, Hans Friedrich, who represents Siemens on the JESSI board, declared that Philips' withdrawal does have consequences for the project. However, he thinks that "this does not mean that SRAM technology will be abandoned altogether." In addition, the complicated projects require more funding than initially expected. A cautious calculation shows that the 1991 budget (544 million European currency units [ECU]) will have to be raised by ECU160 million. The JESSI Green Paper still stipulates an overall budget of ECU3.8 billion, but Paletto bluntly stated that "an additional 25 to 30 percent will have to be found in order to finance the project."

According to Paletto, the European Commission has made a commitment of ECU900 million for the full duration of the project. This means that, after all, the EC Commission is still prepared to finance 25 percent of the project, despite its earlier statements that it would contribute no more than 12.5 percent. The JESSI organization is being crippled by the lack of money. Any funding must be squeezed out of the respective national authorities. The result is that only 10 out of the 54 approved projects are cofinanced by the authorities.

### SUPERCONDUCTIVITY

#### Philips Capable of Determining Critical Temperature

91AN0080 *Rijswijk POLYTECHNISCH WEEKBLAD in Dutch* 1 Nov 90 p 1

[Text] Researchers at Philips' Physics Laboratory (Natlab) have discovered that there is a relationship between the rate of specific chemical variables in ceramic materials and the temperature at which they become superconductive.

This has helped to explain how and why certain materials lose their electrical resistance at a relatively high temperature.

Most superconductive ceramic materials contain, among others, copper and oxygen ions. It was known that superconductivity takes place in crystal planes that contain both oxygen and copper ions. However, until now the temperature at which these materials became superconductive, i.e., the critical temperature, could never be predicted.

#### Critical Temperature

Scientific staff of Natlab have recently discovered that there is a relationship between the bonding strength of copper ions and the surrounding oxygen ions, on the one hand, and the critical temperature, on the other. Thus, it was concluded that high critical temperatures occur primarily in copper compounds in which the holes (so called because they are caused by the absence of electrons) are situated as close as possible to the oxygen ions. According to Philips it is now possible to determine the critical temperature of new compounds in advance.

### TELECOMMUNICATIONS R&D

#### Berlin: Fiber-Optic LAN Adaptation Described

91WS0041A Berlin RECHENTECHNIK-DATENVERARBEITUNG in German Oct 90 pp 10-12

[Article by Dr. Elke Naumann, Volker Gerold]

[Text] The extent of powerful decentralized computing technology has increased enormously in all commercial areas. The necessity of effectively applying this technology is especially important.

The use of local area networks (LANs) is making an important contribution to this. Without such networks, intra-company communication, office automation and process automation up to and including the automatic factory would be inconceivable. Local area networks make it possible to transfer data rapidly and reliably between facilities. These facilities lie within a limited area and are connected by means of a jointly used communications channel.

Defining these networks involves communication technology, the medium, the topology, the access method, and specific connectors. Building on this, the IEEE (Institute of Electrical and Electronics Engineers) standardized various LAN types with different parameters.<sup>1</sup> These standardization efforts provide orientation aids for the national producers of the hardware and software components of a local area network.

Standardized cabling systems and a common communications architecture using standard procedures, protocols and services make possible communication and transparency between the products of various manufacturers. The use of LAN bridges or gateways provides appropriate support for these processes.

The term communications architecture comprises all rules governing the exchange of data between communications partners. It also covers the description of communications functions, the data formats and communications technology.<sup>2</sup>

The ISO (International Standards Organization) has prepared suitable recommendations on this topic. In this way, it also accommodates the goal of achieving a model that is universal and manufacturer-independent. The demands placed on a local area network are high. The question of the environment in which the network is to be installed must be answered just as the question concerning the terminal equipment to be connected. The ever growing need for information, performance data and economic indicators (operating data, production indicators) must be considered when making preparations for the application. In addition, it should be possible to expand the network later at low cost.

Practical experience has shown that different areas of application demand different performance requirements and various other requirements in terms of programs and equipment. In this conjunction, selected methods and processes predict the performance of computer networks under actual conditions of operation. This guarantees the user the selection of local-area networks with the most favorable price/performance ratio for the specified conditions.

A prerequisite for this is a comprehensive data-flow analysis. That is, the user must know all about the data and data distribution. He also must know how much or which data are required when, where and how.

#### Goal of the IHB-NET

Internationally, the networking of computers is greatly advanced. In East Germany, a comprehensive networking structure of the computer facilities, also into the college and institute of technology area, will occur in the 90's.

The plan of the Berlin College of Engineering (IHB) to expand its local area network<sup>3</sup> fits within this framework. Through the use of advanced communications technology, a network solution in the management and administrative area of the Berlin College of Engineering is to be created.

The implementation of a three-step program is planned. The project solution presented in this article is a component of a first stage. The linking of remote locations and connection to the automated data network of the Federal German Post Office by way of suitable gateway technology is planned for a subsequent stage of expansion.

In particular, the following tasks are to be solved by the construction and utilization of a local area network:

— Office operation and data traffic within the college should experience a new quality. This stems from

working with special communications services within the framework of an integrated office workstation that can be connected to a network.

- Using the LAN as the technical basis for solving the rationalization project of the AIV (Automated Data Processing) at the Berlin College of Engineering.

#### Detailed concept for the IHB-NET

##### *System Characteristics*

The project implementation involves the expansion of a local area network of the medium performance class. This expansion uses the hardware and software components of NAGEMA-LOTUNET<sup>4</sup> in a modified form.

The goal-oriented adaptation of the local area network design is directed toward the incorporation of partial solutions. However, this makes it necessary for the user to complete the hardware.

For the IHB-NET, the following system characteristics (see the Figure) can be specified:

- Distance between stations: the distance between IHB-NET nodes is 150 to 4000 m (using special transmitter and receiver modules).
- Bus topology: IHB-NET has the structure of a party line bus and, with about 20 client computers, a range of max. 5 km (second expansion stage).
- Application: office automation and rationalization.
- Interface solution: connection of client computers of the 8-bit and 16-bit class.
- Signal conversion: by means of an optical media access unit (OMZ).
- Branch line: a coaxial cable connection is planned between the OMZ and the client computer.
- Access method: CSMA/CD.
- Network connection: client computers can connect to the network by means of network interface units (NIU). The computers are logically and physically connected to the OMZ in accordance with the two levels of the OSI reference model.
- Network coupling: connection to the public data network by means of gateways.
- Compatibility: by complying with standard interface specifications.
- Transmission rate: data rates up to 1 Mbit/s can be achieved by using the optical media access units.
- Network mechanisms: utilization of implicit network management for servicing the LAN, and existing user and password mechanisms to avoid unauthorized access to project data.

- Performance measurement: damping compensation of the optical level during installation.

##### *Cable Project*

Important milestones for designing the IHB-NET LAN on a fiber-optic cable basis were specified in a cable project.<sup>5</sup> The local area network stations were specified according to the objective of the project. This was, namely, supporting the structure units, in particular the first line stage, during office automation, and effective utilization of existing AIV projects.

The territorial range of the IHB-NET (first expansion stage) corresponds to a bus cable length of about 450 m. It includes the connection of at first 5 client computers (PC 1715) and one server (BC 5120). Implementing the network in the bus topology requires connecting the client computers to a linear transmission medium on the party line bus. The signals are transmitted in all directions and are available to all stations.

The IHB-NET uses fiber-optic cable as the main LAN cable. This is an innovation over previous LOTUNET applications. There are several reasons for using an optical medium in the LAN of the Berlin College of Engineering:

- state of the art,
- large physical range,
- increased transmission rate due to the larger bandwidth,
- not affected by electromagnetic interference.

This network involves transmission over short distances with low demands with respect to distance and transmission rate. Using multimode SI (step-index) fiber-optic cable makes allowance for this. The branch line between the interface of the main cable and the corresponding client computer is made of coaxial cable having a maximum length of 50 m.

The technical implementation of the cable project extends from routing the cables to designing the cable terminations, realized as so-called fiber-optic cable hardware. This hardware consists of the LA4B cable connector with the appropriate KWO-S 631.30 connecting box.<sup>6</sup>

In a second stage of expansion, two branch offices of the Berlin College of Engineering (distance: 2 km each) will be connected to the IHB-NET by means of gradient fiber-optic cable, laid in the post office conduit.

##### *Network Interface Unit*

The local area network stations can connect to the network by way of the NIU (network interface units). The NIU 8<sup>7</sup> of the Scientific Equipment Construction Department of the Dresden Technical University was used without changes for the IHB-NET LAN. This unit connects a client computer both logically and physically to an optical medium access unit (OMZ).<sup>8</sup> In this way, the interface to the LAN with its transmission technology is established on the one side and the interface to

the client computer on the other. The NIU is inserted directly into the corresponding client computer as a circuit board. It implements particularly those functions required for cable access.

#### *Optical Media Access*

A special hardware development is used for connecting to the fiber-optic cable transmission medium. The module (OMZ) is to convert the electrical signals to be transmitted or received by the network interface unit to an active bidirectional optical bus system.

This involves a circuit with the following performance characteristics:

- transmission of data and clock signals without interference and without distortion to the active fiber-optic bus system,
- the connection of several LOTUNET network cards to one OMZ (cluster principle),
- designed in accordance with the ISO standard to ensure compatibility with the hardware of ROLANET 1.

The OMZ design has two receiver sections with one optical receiver each. These are followed by an optional clock generation circuit, the control section, the coupling circuit to the NIU which provides the signals required by ISO 802.3,<sup>4</sup> and the transmission section equipped with two optical transmitters.

#### *Software*

The basic ideas for the IHB-NET come from the Computer Science Center of the Dresden Technical University. This is implemented in the LOTUNET computer network<sup>10</sup> or its commercial version NAGEMA-LOTUNET. It is a modularly structured integrated system for personal and office computers supporting office automation in particular.

Depending upon the use of existing network resources, the following types of services are provided:

- file services (transfer and server services),
- mailbox service,
- printer service,
- operator communication.

The expanded user interface of CP/A, the basic operating system, allows access to relevant databases by means of word processors, REDABAS and the like. Besides the communications software, linking selected application software is a prerequisite for effective work in the network for the users of IHB-NET.

The development of a network-integrated office workstation is conducive to the utilization of special communications services and is designed for rationalizing the workplace of secretaries. Office functions are realized in a special user solution designed for broad user acceptance. In particular, the project solves the following tasks:

- electronic mail (company announcements),
- operator communication,

- attendance planning and checking,
- capture of the service consulting record with transmission of the schedule into the schedule file,
- schedule checking,
- word processing,
- address list.

The project is not limited. Linking additional office functions in a discrete manner is planned. In this way, the facilities of electronic storage and the construction of a central database are being prepared.

A conversion in terms of quality of the running network is planned by linking 16-bit computers (EC 1834), beginning with the server. Then, the IHB-NET LAN will represent a computer and communications infrastructure for the management and the administrative areas of the Berlin College of Engineering. All this infrastructure serves as the technical basis for powerful AIV projects with elegant user interfaces. AIV programs and databases are placed on this infrastructure on the same level as an application (seventh layer in the OSI reference model). These cases involve projects in the areas of research, management, education and training. The structure units for which these AIV projects are being modified and prepared possess corresponding LAN interfaces. Linking the projects into the stable network operation is performed in a step-by-step manner. Performance evaluation

The installation of the IHB-NET LAN is connected with actual experiments for computer-aided performance evaluation of local area networks. The results of these evaluations contain information on configuration as well as performance prediction for the planned network. The basis for this is, among others, a hierarchical 3-layer model in the form of an interactive program system LANEX.<sup>12</sup>

By modelling corresponding layers using closed networks, the LINZ method of mean analysis is used in the program system.

The results provide quantitative data on such performance parameters as waiting time, length of the waiting queue, throughput and load. These indicate the weaknesses in the system.

A directed analysis of the causes and effects provides the potential for taking qualitative and quantitative action on the planning and effective design of the network. A publication on this topic is in preparation.

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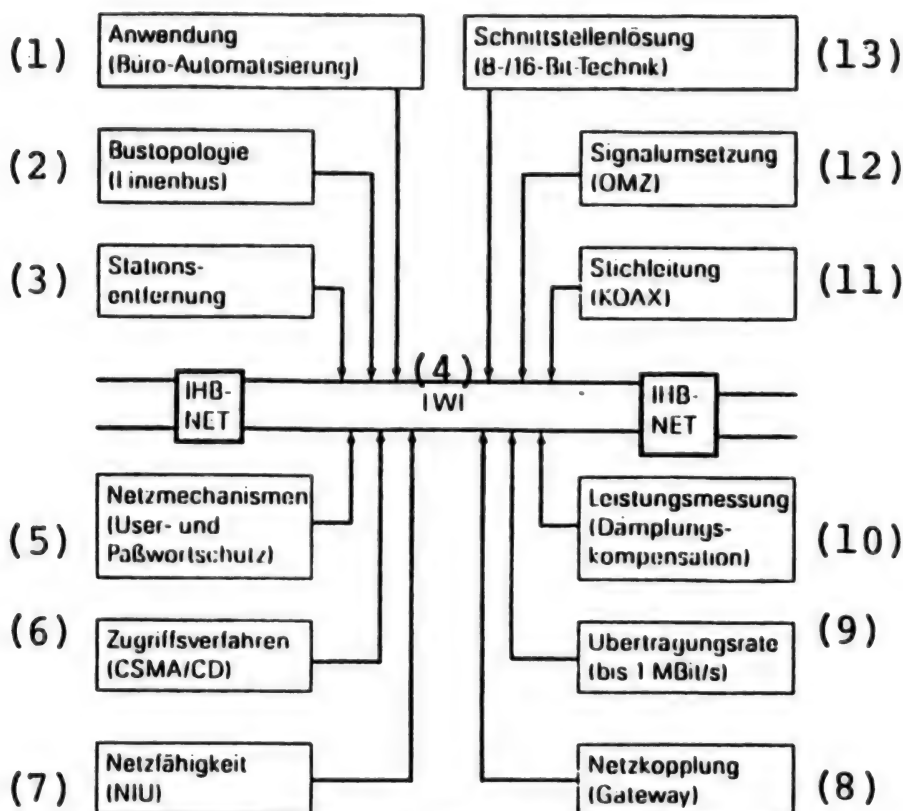


Figure IHB-NET system characteristics

Key: (1) Application (office automation) (2) Bus topology (party line bus) (3) Station distance (4) Fiber-optic cable (5) Network mechanisms (user and password protection) (6) Access method (CSMA/CD) (7) Network connection (NIU) (8) Network coupling (gateway) (9) Transmission rate (up to 1 Mbit/s) (10) Performance measurement (damping compensation) (11) Branch circuit (coax) (12) Signal conversion (OMZ) (13) Interface solution (8/16 bit technology)

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## COMPUTERS

### Hungarian Computer Technology Developments Discussed

91WS0055A Budapest NEPSZABADSAG in Hungarian  
15 Oct 90 p 16

[Interview with Andras Gabor, chief of the informatics department of the Mathematics and Computer Science Institute, by Zsuzsa Regos: "Hungarian Computer Technology Is One-Armed"; first two paragraphs are NEPSZABADSAG introduction]

[Text] Computers are slowly becoming accustomed phenomena of everyday life. Every day the speciality shops are offering an expanding variety of equipment suitable for personal use, and the leaderships of more and more enterprises are awakening to the fact that they cannot postpone the development of network systems.

Andras Gabor, chief of the informatics department of the Mathematics and Computer Science Institute, cannot decide whether to be an optimist or a pessimist when considering the Hungarian use of computer technology.

**Gabor:** While there should be a need for computer technology among the enterprises the market demand has visibly "served its term." Leaders today are incapable of it or are unwilling to think in the long term, because they are forced to make immediate income. Despite this I have faith that sooner or later they will find a way to create computerized systems. I might cite Taurus as a positive example. Financially, of course, this firm does not shine too brightly but still its leaders thought through their needs, looked around at the foreign market offerings, got references from every part of the world, and chose one which they could adopt. Not regarding their financial situation they began to buy the modules needed for the system and bit by bit built up a system which will work well in the future.

**NEPSZABADSAG:** If we are talking about creating a complete enterprise guidance and data processing system is not the purchase of the individual computers the most important point?

**Gabor:** In my judgment there is no quantitative shortage of computers in Hungary today. The problem I see is that the development of the past decade was certainly one-sided. The economy was relatively well supplied with small computers but there was a lack of the centers to bind these together, and of the tools which tie users with the centers. Without these one cannot even talk about the next step, the creation of networks. But a well organized, integrated economy cannot come into being in a country until these networks are built up.

**NEPSZABADSAG:** In more and more places computers are used to keep track of stockpiles, to do the book-keeping and plan, organize and guide production. Are users only doing without the techniques to tie the various links together?

**Gabor:** This actually is what is involved, but one requisite link is still missing, decision making. One cannot work without informatics support for this. This is the condition for the functioning of the several systems. Without bringing in decision making the use of computer technology is like strawberry shortcake without the whipped cream. The cake becomes dry and inedible.

**NEPSZABADSAG:** Would it not make things simpler for the purchasers of computers if the techniques and systems used were somehow regulated and standardized?

**Gabor:** There are two possibilities for this in the developed world. The Swedish method, for example, is very rational. They look on standardization as they do on building housing developments. They set up the houses but do not make paths about them; they just plant grass in the areas remaining. After six months they look to see where the grass is worn the most and build the paths there. So they let life develop on its own and then make the rules. This method can be used very well for standardization at a national level. The other possibility is to accept and adopt the recommendations of international organizations.

**NEPSZABADSAG:** What are the trends throughout the world in the area of standardization?

**Gabor:** Here also, as in clothing or cosmetics, there are fashion dictators. The big computer manufacturers decide what techniques and services will become general throughout the world. If IBM, for example, comes out with something new it will spread like wildfire among users, and this will be the determining factor on the market. Previously Hungary built custom-made, large, unique systems. But in the past two to three years, users began buying what met the international standards. These systems are not as flexible as the earlier ones, and they do not satisfy special needs, but they can be obtained relatively easily and more cheaply. Developing unique systems is an extraordinarily capital intensive thing, and there is not enough money for it in this country or even elsewhere.

**NEPSZABADSAG:** Is it possible that the companies will be able to obtain a larger number of complete systems via the mixed enterprises being formed one after another, using the capital of the foreign partners?

**Gabor:** It is very possible that the foreigners will bring this sort of investment, along with others, into the Hungarian undertakings. They also have a basic interest in seeing the joint work become more efficient with the use of computer technology, and having the capital they invest produce a greater yield. Actually it would be enough to bring in the technology, for well trained programmers can be found in Hungary too. They know

well how much the Hungarian brains are worth. There has been a generation change in computers in the past few years, and for this reason the big Western users had to "rewrite" their old systems. The locals did not undertake this tedious work. So the Western firms invited in Hungarians, yearning for foreign exchange; most of them worked illegally, worked like slaves in cellars, often for starvation wages. In a word, we have the programmers and the software, but we have no one to manage them. So Hungarian entrepreneurs should team up with famous software firms with big marketing, agent, and shop networks.

**NEPSZABADSAG:** Obviously the export of expertise could bring in money with which one could then import computers and systems. In your opinion, how can a market embracing all of computer technology come into being in Hungary?

**Gabor:** I believe that the government should deal with research and development not in general terms but rather, after a basic study of the several applications areas, should invest money only where it can bring results within two to three years and bring concrete profit. If the government would put out a little money in this way, then the foundations and the enterprises getting tax exemptions or concessions would certainly put in something more. This is the way to start so that Hungarian computer technology, for the time being one-sided, could develop further.

#### **Status of Hungarian Artificial Intelligence Research Discussed**

*91WS0055B Budapest NEPSZABADSAG in Hungarian 15 Oct 90 pp 13-14*

[Interview with Ivan Futo, university professor and director of Multilogic Computer Technology Ltd., by Attila O. Szabo: "Small Teams and Software Superpowers"; first paragraph is NEPSZABADSAG introduction]

[Text] There are already thinking robots in our world as it rushes toward the third millennium. In developed countries entire rows of robots work without human intervention. In Japan, indeed, computers which see and speak are not rare. Hungary is not among the countries leading in technology, but domestic experts can be found among those dealing with research on artificial intelligence. But what does the concept of artificial intelligence cover, and what can the Hungarian researchers show us? We asked this of Ivan Futo, university professor and director of Multilogic Computer Technology Ltd.

**Futo:** By artificial intelligence we mean a computerized system which is a mechanical realization of a form of activity characteristic of a human being. We think of such things as seeing, hearing, speech, and especially thought. There were trends that tried to model the human brain. This effort, however, was not successful so today we make mathematical-logical tools which can execute multistep inferences. The so-called expert systems constitute the most common applications area of

such systems. These take the place of human expertise in that their decision mechanism is described by a set of rules established on the basis of information collected from experts who know the given area best. The application of artificial intelligence means the collection of these lawful relationships, transforming them into formal language and then putting them into operation. With the aid of this a computer behaves in a way similar to an expert.

**NEPSZABADSAG:** Should we regard as utopian the conjecture that someday machines will speak, see, and think?

**Futo:** It is still a very distant prospect that a computer will be able to take over every human function. But there are certain achievements. They have made a self-propelled automat which is capable of navigating without any sort of human intervention. It recognizes objects in the field, can evaluate their distance and can avoid obstacles. These devices are used in military and industrial practice. Speech recognition represents a more difficult problem. Practical use of systems which can recognize more complicated, continuous speech—which recognize the voice of any individual—can be expected after 10 years even at best. There are already significant achievements in understanding natural language. In Japan, for example, in connection with the fifth generation projects, they have prepared translation systems which translate from English to Japanese and from Japanese to English. By text recognition we mean that not only does the system syntactically describe and store the text but also that it can interpret texts independently on the basis of its memory.

**NEPSZABADSAG:** What sort of theoretical achievements does research on artificial intelligence have in Hungary?

**Futo:** It has not only theoretical but also practical achievements. As for the theoretical achievements, very good search algorithms are prepared in Hungary; the systems are based on these. There have been and are today serious theoretical achievements in the mathematical-logical direction as well, in the Mathematics Research Institute, at Szamalk [Computer Technology Applications Enterprise] and the SZKI [Computer Technology Research Institute and Innovation Center]. As for practical achievements, at the SZTAKI [Computer Technology and Automation Research Institute] they prepared a program, using a relatively original method, for the analysis of natural Hungarian language. There is also research on understanding speech. The Instrument Service of the Hungarian Academy of Sciences, for example, has demonstrated a speech understanding device which could understand certain command words and which is capable of reacting to them.

**NEPSZABADSAG:** Can these achievements compete with programs prepared by the computer superpowers of the world?

**Futo:** It is difficult to say what position Hungary occupies in this area. There are partial areas where we are in a very good position, but there are also areas where the lag is gigantic. At the end of the 1970's artificial intelligence research suddenly got into a very good position in Hungary. When the fifth generation computer projects based on logical programming were prepared it turned out that a logical programming school had been operating in Budapest for years; it had the tools and the application areas. But since then gigantic development has been started by the leading economic powers and so a Hungarian researcher falls behind in minutes. Since then our relatively good situation has been deteriorating, and I no longer consider it true that Hungary is a great power in software. On the one hand suitable tools are lacking, and, on the other hand, the development bases which would have supported this research have disappeared. We are facing competition which is working with much better tools and more ample resources. So, with the exception of a very narrow area, we are being forced into the background. It is difficult to stop this process. Since the end of the 1970's we have switched to so-called following development and since the easing of the COCOM [Coordinating Committee for Export Control] restrictions Hungarian products cannot compete with their Western counterparts even on the domestic market.

**NEPSZABADSAG:** What are those areas where the Hungarian researchers are still competitive?

**Futo:** I view the situation rather pessimistically, but I feel that there is a possibility for us to prepare legal expert systems. This has a reassuring future in Hungary today for our legal system is being transformed. With the tools available to us we could prepare expert systems which would operate like a person who understood the law.

**NEPSZABADSAG:** You are working on the informatics systems for the world exposition. To what extent can the results attained in artificial intelligence research be used in this area?

**Futo:** I do not believe that this would be directly applicable at this moment. If we want a reliable system for the world exposition we cannot build into the informatics system elements now under development. But they might be used in two areas. The information systems for the world exposition could be supported with expert systems. The other area is that we might build a so-called intelligent informatics structure network—in the event of a favorable bid. But I emphasize that at this moment we have no concrete plans for the use of the tools of artificial intelligence when holding the world exposition.



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